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INFORMATION CHANNEL UTILIZATION UNDER VARYING
RESEARCH AND DEVELOPMENT PROJECT CONDITIONS:
AN ASPECT OF INTER-ORGANIZATIONAL
COMMUNICATION CHANNEL USAGE

Wayne Dean Bodensteiner

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1970

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RESEARCH AND DEVELOPMENT PROJECT CONDITIONS:
AN ASPECT OF INTER-ORGANIZATIONAL
COMMUNICATION CHANNEL USAGE

by

WAYNE DEAN BODENSTEINER, B.B.A., M.S.

DISSERTATION

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for the Degree of
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W.D.B.

Austin, Texas
November, 1969

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PART I
INTRODUCTION

CHAPTER ONE

INTRODUCTION

The state of theoretical development in the communication \longleftrightarrow organization interface has been such that no single, integrated body of literature has been accumulated; and that any really useful theory of communication in organizations must ultimately take into account the theories and empirical evidence of a wide range of pertinent conceptual tributaries. We have been restricted by a much too limited, sometimes confused, concept of what communication is in organizations. We have been shackled with similarly unworkable and frequently unsystematic conceptions of organizations.¹

- Lee Thayer (1967)

The general purpose of this study was to enlarge the understanding of the interface between transacting research and development organizations and the process of information transfer and diffusion within the scientific and technical communication system. The focus of this research was upon the utilization of interpersonal communication channels between transacting organizations concerned with research and development projects under varying and uncertain project conditions.

¹Throughout this dissertation the symbol \longleftrightarrow is used to denote that a relationship and common boundary exists between two variables.

In the last two decades, as the rate of technological progress and the need for innovation of new technology has grown and been recognized, increasing attention and interest has been focused on the management of technical and intellectual resources in general and the management of research and development organizations in particular. Few topics in this area have received more attention than the process of information transfer, flow, and utilization among scientists and engineers conducting research and development. A review of the literature indicates that research on scientific and technical communication can be classified into two areas: (1) documented information and information-retrieval and, (2) "user" studies. The first of these areas of study is primarily concerned with formal publications and documented information and the processes enabling their dissemination, storage, indexing, and retrieval; while the latter is concerned with the manner in which scientists and engineers actually utilize the existing communication system.

To date, the large majority of research and study has been devoted to problems that concern formal publications and documented information. These formal communication channels have been viewed by many (Committee on Scientific and Technical Information, 1965; Abelson, 1968)

as synonymous with the transfer and exchange of information among scientists and engineers. Dramatic figures on the growth in the number of papers, abstracts, and journals (Sandek, 1967) have thoroughly emphasized the importance of computer/mechanical retrieval systems and the formal communication channels.

A review of the literature, published reports, research effort and the resources allocated and spent suggests that the formal channels of the scientific and technical communication system have, in the past, received by far the greatest amount of attention, emphasis, research, and resources/money (Federal Council For Science and Technology, 1964; National Science Foundation, 1966; Cuadra, 1966; Swanson, 1966).

A limited but growing body of data has been collected and published that is directly concerned with the behavior and attitudes of scientists and engineers, and with identifying the utilization, importance, and interface of the informal/interpersonal communication channels. Informal scientific and technical communication channels are defined as those that involve person-to-person interactions or interpersonal modes of communication. These include written memoranda or correspondence, teletype/telegram messages, telephone conversations, and

face-to-face interactions.

Studies conducted by Glock and Menzel (1958), Allen (1966), Rosenbloom and Wolek (1967), and Graham and Wagner (1967) empirically found that both the formal and informal communication channels play important roles in the transfer of technical information by scientists and engineers in research and development organizations. One of the important (and surprising to many) findings of these studies has been the relative importance and reliance that scientists and engineers place on the various informal/interpersonal communication channels. These studies have shown that the informal channels are utilized in a majority of the communication instances by scientists and engineers and that many of their needs can only be met by utilization of these interpersonal channels.

The systems approach as manifested by systems analysis, systems management, and general systems research has resulted in a recognition that the numerous and varied channels of information transfer are all vital components of a total scientific and technical communication system. A systemic view of the information exchange and transfer process must embrace all the components of the formal and informal communication channels, all the provisions, all the facilities, all the occasions and arrangements, and all the customs and norms of an

organization or discipline that determine how scientific and technical information is transmitted (Menzel, 1966, p. 1000; Garvey and Griffith, 1967, p. 1011).

The objective of the user studies was to determine empirically the manner in which the existing communication system functions, i.e., to examine and document the information-exchanging behavior of scientists and engineers in order to single out the features which make the means and occasions of information transfer more or less able to meet the individual scientist's and engineer's needs (Menzel, 1959, pp. 417-418). These studies were limited to one aspect of the over-all process and system of technical communication. This one aspect was the determination of the means by which substantive information in science or technology, originating in a specific organizational setting, is acquired and put to use by scientists and engineers conducting research and development within that same organizational setting or within another organizational unit.

These studies did not examine or discuss the many "other" aspects of the over-all process of technical communication and other sorts of information which comprise the total scientific information system. These "other" aspects include information or knowledge of

schedules, budgets, or personnel; knowledge of technical, contractual, administrative, and budgetary problems or constraints directly related to a research and development project or organization; or inter-organizational project relationships, problems and differences between transacting organizations (prime contractor, sub-contractors/vendors, government/sponsor organization) of a common research and development project.

It is paradoxical that a very limited amount of emphasis, attention and research has been focused on these organizationally vital and required "other" processes of technical communication. These processes pose different requirements, questions, and answers of both individual scientists and engineers engaged in technical projects and of managers/directors of research and development projects. These "other" processes are of great significance to the effective functioning of a technical organization and normally comprise a majority of the organizational energy and effort expended between transacting organizations mutually engaged in a research and development project.

The increased emphasis and resources/monies that both government and private organizations have given to research and development projects and to the innovation

of technology in recent years have resulted, however, in relatively little recognition of the significance, problems, and utilization of informal/interpersonal communication channels between the transacting technical organizations or units engaged in research and development projects. Yet under conditions that include stringent contractual time constraints, limited and highly valued resources, and exponential increasing costs of facilities and personnel, the successful completion of a technical project from both an organizational and professional viewpoint is dependent on the effective and efficient functioning and utilization of direct interaction and informal communication channels between the project transacting organizational entities.

Shapero, in his discussion of the management of intellectual resources, suggests that there is a small but growing body of data that is directly concerned with the characteristics and behavior of research and development organizations and the way in which information is diffused and used in the scientific and technical community:

What is available suggests strongly that it is already possible to achieve substantial improvements in the management of the new world of one-of-a-kind, by crude application of what is available. It also suggests that it should be possible

in the near future to assemble and/or grow a cohesive and coherent body of relevant management knowledge (Shapero, 1969, p. 30).

Nature and Scope of Study

This study investigated the process of inter-organizational communication by examining the utilization of interpersonal communication channels between transacting organizations mutually engaged in research and development projects and by treating each transacting organization as a communication entity. It focused on the organizational importance of direct interaction through the informal/interpersonal channels and their utilization in the over-all or total process of scientific and technical communication. This study did not examine intra-organization communication nor investigate the communication behavior of individual scientists and engineers and their means of transferring technical information from one to another as previous user studies have done.

The major premise of this study was that the utilization of interpersonal communication channels between the transacting organizations mutually engaged in a research and development project is directly related to varying project conditions and project uncertainties. It attempted to answer the following questions: Is the

frequency of communication channel utilization between project organizations a function of unforeseen project difficulties? When project difficulties and uncertainties arise are there differences/similarities in the utilization of the various interpersonal communication channels? Does the determinability and complexity of the products or services that are the mutual concern of the transacting organizations affect the frequency of communication channel usage? Is channel utilization between transacting organizations related to the nature and characteristics of previous or prior inter-organizational relationships?

Two separate research and development projects were examined. One project involved the following transacting technical organizations: A large industrial R&D prime contractor, several sub-contractors/vendors and a government sponsoring and monitoring agency. The second project involved a medium size, non-profit prime organization and several sub-contractor and vendor organizations.

Data from the archival business and administrative records of the prime organizations concerned with each respective project were used to compile descriptive statistics and graphic presentations and measures of the

utilization of interpersonal communication channels between the transacting organizations of each project. Data from project histories obtained by interviews with project directors and technical managers were used to derive and designate periods of uncertainties; determinability and complexity of products or services between organizations; and the nature and characteristics of relationships between the transacting organizations.

The frequency and utilization of each communication channel were related to the varying project conditions to determine the relationships between these major variables. Various tests of the relationships were conducted for purposes of analysis, evaluation, and clarification of the compiled data.

Organization of Study

This dissertation is organized into five parts: introduction; background and theoretical development; research design and methodology; analysis and examination of interpersonal communication channel behavior; and summary, discussion, and conclusions.

Part II consists of two relevant literature chapters which provide a background and framework for the remainder of this study. Chapter Two discusses the scientific and technical informal/interpersonal communication

channels and examines the research relevant to the utilization of these channels by individual scientists and engineers. Chapter Three involves an extensive discussion of the literature relating to the basic characteristics and communicative capabilities of the informal/interpersonal channels. This develops a framework from which the remainder of the study can be viewed.

Part III translates this framework and background of interpersonal communication into a set of workable hypotheses and discusses the research design. Chapter Four specifically states and discusses the basic and supporting hypotheses of the study. Chapter Five presents an extensive discussion of the basic research design and methods used to collect the data and measure the variables studied. Statistical methods to be used are identified and the reasons for their selection are indicated. In Chapter Six the sample is introduced. The characteristics of the sample are presented with a particular emphasis on the differences between the two projects and their respective transacting organizations.

Part IV contains the analysis of the data. Chapter Seven basically explores the question: Is the utilization of interpersonal communication channels between the prime and sub organizations of a research and devel-

opment project a function of uncertainties arising from unforeseen or unexpected project problems. The first supporting hypothesis is intensively analyzed and examined. Chapter Eight explores two different questions regarding types of uncertainties or factors which influence and affect the degree of total interpersonal channel utilization between transacting sets of organizations. The two types of uncertainties or factors are measured and analyzed in terms of the second and third supporting hypotheses.

In the final part, composed of Chapter Nine, the results and conclusions of the study are summarized. These results or findings are then used, along with theory and data from other research, to present a general theoretical explanation or framework of the reduction of uncertainty through the utilization of interpersonal communication channels. The chapter closes with a discussion of the implications of this research and suggestions for further research.

PART II

BACKGROUND AND THEORETICAL DEVELOPMENT

PART II

BACKGROUND AND THEORETICAL DEVELOPMENT

The two chapters in this section provide a framework for the remainder of this study. The subject of this study spans several areas and topics which are relevant to inter-organizational communication between research and development/technical organizations. Within this broad span there is no single area or body of literature that coincides directly with the subject of this study. There is one body of literature concerned with the use of the formal and informal/interpersonal communication channels by scientists and engineers engaged in research and development. This literature has concentrated on the means utilized in meeting the technical communication needs of these individual scientists and engineers. There is a second broad body of literature scattered throughout the fields of anthropology, communication theory, information theory, linguistics, semantics, social psychology, and sociology which is concerned with the cognitive transference of meaning, capacities, and communicative capabilities/dimensions of the interpersonal communication channels.

Chapter Two discusses the research literature on

the informal/interpersonal communication channels of the scientific and technical communication system. Chapter Three presents a framework from which to view the communicative capacities and cognitive capabilities of the informal/interpersonal channels. Together the two chapters develop a background and theoretical basis for the study of interpersonal information channel utilization between transacting organizations of a research and development project.

CHAPTER TWO

INTERPERSONAL/INFORMAL COMMUNICATION OF SCIENTIFIC AND TECHNICAL INFORMATION, A REVIEW OF THE RELEVANT LITERATURE

There is a large body of literature that is concerned with formal communication channels and their utilization by scientists and engineers. There is also a limited but growing body of knowledge concerned with utilization of the channels of communication employed by scientists and engineers relative to their research and development activities. While the latter literature has concentrated on the investigation of the communication needs and methods of individual scientists and engineers, it has also developed a limited amount of information relevant to inter-organizational communications.

In the exploration of the communication channels in this study, each transacting research and development organization was treated as a communication entity. But these organizations do not, in reality, communicate and interact with one another as entities. It is the research directors and managers, the key scientists and engineers of each project who interact and communicate with one another in this inter-organizational communication process. It is the scientists and engineers who

function as the transmitters and receivers, the encoders and decoders, and the filtering devices for the organizational entities they represent. Therefore, the body of knowledge that pertains to the individual scientific and technical communication needs of scientists and engineers was reviewed.

Systemic View of the Technical Communication Process

Chapter One briefly discussed those studies concerned with communication experiences and needs of scientists and engineers. As was pointed out, it has not been until the last decade or so that research emphasis has been placed on the interpersonal or informal channels of communication as well as the formal channels. The systemic view of scientific and technical communication necessarily requires comprehension of the total communication system or processes:

The scientific and technical communication system is the totality of publications, facilities, occasions, organizational arrangements, and customs which affect the direct or indirect transmission of information among scientists and engineers. It encompasses both the formal and informal channels of communication (Glock and Menzel, 1958, pp. 5-6).

William Garvey, director of the Scientific Information Exchange Project of the American Psychological Association, viewed the exchange of technical information

as a system of social interaction among scientists and espoused that information transmission and exchange within a discipline evolves in an orderly manner. He recognized the social, economic, and dynamic dimensions of the system and the special relevance of formal and interpersonal/informal channels of communication to these dynamics (Garvey and Griffith, 1967, p. 1011).

Rosenbloom and Wolek (1967) also found that it is essential to view the process of scientific and technical information process as a systemic process:

Although the informal channels may appear to be haphazard and perhaps inefficient, it seems more useful to recognize them as a natural functioning of a highly sophisticated and well structured social system. Hence, a systematic view of the process of information transfer must embrace both its formal and informal components (p. 124).

The latter body of literature describing the importance and role of the informal/interpersonal channels to individual scientists and engineers and the interface of this role with the total technical communication system is most relevant to the questions asked in the study reported here. As was pointed out earlier, this study examined the utilization of the interpersonal or informal communication channels between the scientific and technical organizations mutually engaged in a research and development project. For the purposes of this study in-

formal or interpersonal communication channels were defined as those channels that involve personal interactions. The channels examined were written correspondence or memoranda, teletype/telegram messages, telephone conversations, and face-to-face interaction. The important feature of informal and interpersonal contacts is that they involve person-to-person interactions and it is with these interpersonal interactions between scientists and engineers representing transacting organizations of a research and development project that this study was directly concerned.

Interpersonal/Informal Communication in the Technical Information System

There is now a limited amount of documentation (Menzel, 1959; Halbert and Ackoff, 1959; Orr, Coyl, Leeds, 1964; Auerbach, 1965; Allen, 1966; Rosenbloom and Wolek, 1967; Graham, 1967) for the great role played by informal, unplanned, person-to-person communication in the experiences of scientists and engineers, often in ways that affect their work vitally. One of the early studies which encouraged further research on interpersonal communication channels was the study by Halbert and Ackoff (1959). This operations research study of the scientific activity of 1500 chemists reported the following percents

of time spent by them in communication during working hours:

written, published	4.8 percent
written, unpublished	9.0 percent
oral, non-discussion	8.9 percent
general discussion	10.0 percent

The importance of interpersonal communication channels is clearly evident, as it shows that 27.9 percent of the scientist's working time was spent on informal/interpersonal scientific communications.

Other early studies which found that interpersonal communication was an important and vital process to scientists and engineers were Bernal (1959), Fishenden (1959), Glass and Norwood (1959), and Herner (1959). These studies demonstrated qualitatively the importance of oral communication for acquiring needed information and for learning of work of major significance. A heavy reliance on verbal communication with scientists working in their own areas or fields of research was prevalent.

In a study of communication in the biomedical sciences, Murtaugh and Payne (1962) found that the interpersonal channels of communication played the most important role in the transfer and exchange of scientific information. They concluded that "...oral communications

and correspondence constitute the fundamental, most powerful, immediate, and effective means of conveying information in the scientific and professional world". They went on to say that methods of personal communication are perhaps the dominant factors in the rapid post-war advancement of research and development.

There have been a small number of other studies conducted which examine the use of the formal and informal communication channels by individual scientists and engineers. Four of these studies are briefly reviewed below. These four studies were selected because of the research methods and techniques used, and the size, comprehensiveness and characteristics of their samples.

The Menzel explorative study of 1958 was one of the first studies to attempt a comprehensive exploration of the total exchange and flow of scientific information among research and development scientists. The Menzel study developed numerous data from the interviews of 77 scientists and tabulated the results in various forms. The Menzel data most relevant to this dissertation are those dealing with the channels of communication required and used by scientists to keep them informed of scientific developments. The data were broken down into

channels of publications, meetings, conferences, reprints, newsletters and personal communications with the results revealing the following usage:

Informal - interpersonal channels 55 percent

Formal - document based channels 45 percent

(Menzel, 1958, p. 56).

The second study (Auerbach, 1965) examined how scientists and engineers acquire and utilize technical information in the performance of their tasks. Face-to-face interviews were conducted with 1375 scientists and engineers engaged in research and development work for the Department of Defense. The Auerbach analysis unfortunately was not carried through to an integrated interpretation but does provide long listings of individual findings and uninterpreted data. From Auerbach findings and data the following sources of information used to accomplish tasks by scientists and engineers were identified:

Informal - interpersonal channels 55 percent

Formal - document based channels 45 percent

(Auerbach, 1965, pp. 1-12, 3-15).

The third study (Rosenbloom and Wolek, 1967) was an empirical descriptive study of the information behavior patterns of 3200 scientists and engineers in research

and development organizations. Their data reveal that engineers and scientists use sources outside the organization in an amount almost equal to sources within their own organization. The reported uses of scientific and technical communication channels were:

Informal - interpersonal channels 55 percent

Formal - document based channels 45 percent

(Rosenbloom and Wolek, 1967).

The fourth study (Graham and Wagner, 1967) examined the functions and problems of informal scientific and technical communication by interviewing 326 managers of research operations in research and development organizations. According to the response of their sample of research leaders; most scientists and research engineers transmit a substantial portion of their scientific information through interpersonal channels. Their methods range from direct, personal conversations and phone calls, through meetings and conferences, to memoranda and correspondence. The results were:

Informal - interpersonal channels 54 percent

Formal - document based channels 46 percent

(Graham and Wagner, 1967, p. 69).

Compiling the data taken from the four studies showed that the interpersonal or informal channels play a

fundamental and important role and are utilized by individual scientists and engineers in a majority of the instances in their daily information obtaining activities. The interpersonal channels of the scientific and technical communication system are considered by the professionals as the primary channels and of the greatest importance to their successful accomplishment of research and development tasks. Table 2-1 details the pertinent data of the four studies. The mean of these four studies was:

Informal - interpersonal channels	55 percent
Formal channels	45 percent

Particularly relevant to the process of interpersonal communications between organizations is the fourth study (Graham and Wagner, 1967) discussed above. This study examined individual communication behavior and patterns of research project managers and research leaders. This sample of research leaders showed that they utilize the interpersonal channels in a majority of the instances of technical communication and that this is the natural mode of their communication behavior and process. "Often-times we cannot help but communicate informally; it comes naturally." (Graham and Zavala, 1967, p. 39). It is these same research leaders and managers who represent

Table 2-1

Four Studies Showing The Utilization of The Formal
And Informal Communication Channels By Scientists
And Engineers

Study	Sample	Communication Channel Usage*	
		Informal	Formal
Menzel (1958)	77 scientists	55%	45%
Auerbach (1965)	1375 scientists	55%	45%
Rosenbloom and Wolek (1967)	3200 scientists and engineers	55%	45%
Graham and Wagner (1967)	326 managers of research and development projects	56%	44%
Arithmetic average of all data		55%	45%

*Definition of the formal and informal communication channels were in accordance with these found in Chapter One.

organizational entities and do much of the communicating between research and development organizations. The fundamental importance they place on the interpersonal channels when acting as individual information seekers extends and carries over as a natural function when representing interacting project organizations. It is this inter-organizational interaction by means of the interpersonal channels that the study reported in this dissertation examined.

The user studies also suggest that the essential function performed by the interpersonal/informal channels for individual scientists and engineers is the exchange of ideas with other professionals to solve mutual research problems and to solve situations which can cause uncertainty and stress. This function directly relates to the major premise of this study which is: the utilization of interpersonal communication channels between the transacting organizations engaged in a research and development project is directly related to the varying project conditions and project uncertainties. The variables "project conditions and project uncertainties" which were investigated are similar, if not synonymous, with the "research problems and uncertain stress situations" referred to above.

Table 2-2 shows the percentages of mentions of values by 326 research project leaders when asked: "In what way are informal communications essential to the transfer of scientific and technical information?" The data shows that 39 percent view "saving time in solving a problem" as the greatest value, 20 percent believe "obtaining help in solving a problem" is the greatest value of the interpersonal channels, and 3 percent view "learning of failures and negative results" as the greatest value. By grouping these three values together into a general "problem or uncertainty" category, the data reveal that 62 percent of the research leaders view the function of problem solving and awareness of failures as the most essential function to scientists and engineers performed by interpersonal communications (Graham and Wagner, 1967, p. 78).

Similarly, Rosenbloom and Wolek (1967) found that when an engineer or scientist considers himself relatively inexperienced with the scientific or technological problem context within which the information arises, he is more likely to use interpersonal or informal communication sources and channels. Graham and Zavala (1967) found that, often, research leaders and managers of research and development projects cannot help but

Table 2-2

Ways In Which Interpersonal Communications Are Essential
To The Transfer of Scientific and Technical Information
By Research Managers and Research Leaders

Sample, N = 326 Research Managers and Research Leaders

<u>Ways</u>	<u>Mentions of Value Percent*</u>
To save time in solving a problem	39
To learn about current research	25
To obtain help in solving a problem	20
To become aware of unpublished work	19
To learn about details of a study	19
To learn about new ideas	13
To gather a variety of information on a topic	10
To assist in finding published information	6
To keep aware of what is published	3
To learn of failures and negative results	3
To train researchers	3
To save money in solving a problem	2

Source: Graham and Wagner, 1967

*Adds to more than 100% since more than one mention of value given by some project leader.

communicate informally through the interpersonal channels; it gives them reinforcement on their own thinking. A scientist or engineer may get an immediate answer to a problem or he may try out something to see if it will be "shot down." Interpersonal communications allows one research leader to help another do things neither could, to alone. Zavala and Graham suggest that:

In the free asking of critical questions, the delineation of concepts or points of view result from the direct interaction of more than one mind. Also, a scientist or engineer cannot always find a colleague at his own organization who is interested in his problem. Therefore, he attends meetings or employs other channels of informal communication in order to interact with such peers. Such exchanges of ideas with other competent researchers can aid a man who is blocked on solving a research problem (1967, p. 39).

The relevance of the use of the interpersonal/informal channels by scientists and engineers is illuminated when integrated with studies showing measures of research creativity, productivity, and motivation related to communication channels. An especially important function appears to be its contribution to the development and exchange of new ideas, to innovation and creativity. "New ideas are the tapers that light off new research efforts and provide the theoretical guidelines for scientific advances. There are numerous findings in the literature indicating that personal contact is of overriding importance for

industrial innovation" (Gloege and Graham, 1967, p. 21).

Menzel (1959) found that useful information obtained "accidentally" and the unplanned acquisition of information are primarily transmitted through the interpersonal/informal channels and that this personal interaction is also vital to the kindling of enthusiasm and innovation. Menzel concluded that the formal means of communication serve the scientist most efficiently when he knows precisely what he is looking for. But when it comes to bringing scientists together with information the significance of which to their own work they have not anticipated; when it comes to pushing out the frontiers, it may be that the system of informal communication is as reliable a mechanism as one can get (1959, p. 425).

Glass and Norwood (1959) reported that the majority of scientists they studied indicated casual conversation as the most frequent source of information about tasks important to the development and progress of their own ideas (pp. 196-197). Similarly, Pelz and Andrews (1966) found that frequent interpersonal interaction and communication with other scientists is an effective contributor to a researcher's effectiveness and creativity. Frequent interpersonal communication with colleagues and

other professionals provides new ideas - jostling a man out of his old ways of thinking about things (p. 52).

Shilling, Bernard and Tyson (1964) found higher research productivity in research and development organizations which permit unrestricted use of long distance telephone facilities and encourage travel and visits to other organizations than in organizations which establish more restrictive interpersonal communication policies. The increased frequency of interpersonal interaction through the use of the informal communication channels of telephone conversations and face-to-face interactions results in higher research productivity. Pelz and Andrews (1966), using multiple measures of research productivity, found that among basic research scientists, development and applied research scientists, and engineers; those who have relatively frequent interpersonal interactions tend to perform at higher levels than those who utilize the informal channels to a lesser degree. Similarly, Parker, Linwood and Paisley (1968) found that when comparing both the use of formal media channels and informal/interpersonal sources, the use of informal scientific and technical communication is the strongest single predictor of research productivity of scientists. Their data provide support for the argument that costs of interpersonal

communication channels such as telephone calls, travel to meetings, and visits, respectively, to other research and development organizations can be justified as likely to increase research productivity.

Related to the importance of interpersonal communications for creativity and research productivity is the motivating effect on research efforts produced by informal exchanges of ideas and information. The curiosity that leads to intense research activity frequently has its basis in previous interpersonal communications. Bondi (1962) stated that it is only by personal talk between research professionals that unformed ideas can travel from one person into another, and that the motivation for different approaches to problems and research can be communicated and discussed. It is only by talking that the scientist can discover which point of his approach that is so clear to himself is particularly unacceptable to others. Graham (1967) hypothesized that one of the most important values of informal communications to science and technology is its ability to motivate researchers. His data showed that most researchers (about 70 percent) value interpersonal communication very highly for its motivating influence. Only 22 percent felt that formal communications are more important

as motivational stimuli (p. 119).

Summary

A review was made of the research "user studies" concerned with the scientific and technical communication system - studies showing the communication behavior patterns of individual scientists and engineers. Some have viewed the communication behavior of professionals as a total system, and have examined the utilization of both the formal and the informal or interpersonal channels of communication by both research scientists and engineers. This literature has concentrated on the communication behavior of individual scientists and engineers.

Four of these studies were reviewed and the results suggest that the interpersonal channels of communication play the most important role in the transfer and exchange of technical information and that interpersonal interactions constitute the fundamental, most powerful, immediate, and effective means of conveying information in the scientific and professional world. One study which sampled research project managers and research leaders revealed that they utilize the interpersonal channels in a majority of the instances of technical communication and that this is a natural function in

their basic communication behavior patterns. Accordingly, it is these same research leaders and managers who represent and interact for organizational entities when communicating by means of the interpersonal channels between organizations.

These studies also suggest that the interpersonal channels perform several essential functions for individual scientists and engineers. One of these functions is the exchange of ideas with other scientists and engineers to solve mutual research problems and situations which can cause uncertainty and stress. These functions relate directly with the variables of project conditions and project uncertainties which will be investigated in this dissertation. Other relevant functions performed by the use of interpersonal channels is their contribution to increased research creativity, innovation, productivity and motivation behavior by individual research scientists and engineers.

Nowhere in the literature was found an attempt to systematically examine the inter-organizational communication behavior between transacting research and development organizations utilizing the interpersonal channels of communication. While the fundamental work in scientific and technical communication theory has advocated

the total systems approach, almost all of the emphasis has been on the communication behavior and patterns of individual scientists and engineers. There has been almost no research conducted on the other vital and important processes of the total communication system.

CHAPTER THREE

INTERPERSONAL COMMUNICATION CHANNELS - THEIR LIMITATIONS, CAPACITIES, AND CAPABILITIES

A framework for the study of the fundamental characteristics of the different levels of interpersonal communications described in the remainder of this dissertation is presented in this chapter. Chapters One and Two introduced and briefly described the four channels which comprise interpersonal communications. This chapter will examine from a theoretical viewpoint these four channels and develop a basis for the measurement and analysis, in Part IV, of the use of these channels in relation to project uncertainties and conditions.

Communication comes from the Latin word *communis*, common. When we communicate we are trying to establish a "commonness" with someone. That is, we are trying to impart information, an idea, or an attitude.... "the essence of communication is getting the receiver and the sender tuned together for a particular message" (Schramm, 1954, p. 3). The definitions of communication are as numerous as the many areas of research which explore and investigate the communication processes. Mathematical and statistical communication theory, sociology, psychology, linguistics, semantics, semiotics, and organ-

ization behavior, to name but a few, have all made important contributions to human communication theory. And, all have modified definitions of the term communication according to the purposes of their areas of interest. The above definition, however, is an adequate general working definition as it includes the basic ideas which the above areas normally emphasize.

When persons interact and communicate they are trying to establish a "commonness" with each other, an understanding of true meaning, a co-orientation with one another. Effective communication requires that the state of material in the final stage be like that put in at the beginning. "Perfect correspondence is unattainable in real life, of course, but it may help to be aware of the need for efforts toward transmitting concepts from sender to receiver which are as unchanged as possible" (Kolasa, 1968, p. 280). Misunderstanding, to some degree, is always present in the communication process. If one views the different channels available and the inherent limitations and capabilities of each channel, it is small wonder that every attempt to communicate results in at least a partial misunderstanding.

Not all data or messages can be considered information. Thayer (1967) has made a useful distinction

between data and information and suggests that the event or occurrence of consciously or unconsciously ascribing meaning or significance to raw sensory data and thus of converting it to information is the process of communication. MacKay has pointed out that...."a message provides information only insofar as it reduces uncertainty, and the amount of information is determined by the amount the uncertainty is reduced by the message" (1964, p. 172).

Hymes (1967) suggests that communication is the basic metaphor in the human interpretation of experience, and anything may count as communicative, if a person takes it so. It is common in our society, however, to assume that words are the only means of communication, whereas commonplace silent actions are not interpreted as having communicative value. The fact that words are sounds referring to ideas or events is frequently overlooked altogether and often is never recognized. In the act of speaking or writing, words are invested in men's minds with substance and body, so that words often become "things" in themselves.

Four Channels of Interpersonal Communication - Concept of Richness

If we communicate not only words but by words and other means, what, then, is the total process by

which individuals communicate with one another? It is with this question that the remainder of this chapter deals. Interpersonal interaction and communication can occur, basically, by means of written messages or correspondence, verbal language, or by direct face-to-face interaction. The written or printed word, transmitted by memoranda, correspondence, telegraph or teletype, or in any other way; the spoken word, either by face-to-face interaction, telephone, radio, or tape recordings - these are the obvious and common forms of interpersonal communication. In addition are also other, less common, forms of communication. Variations in pitch inflection, loudness, and rate of speech furnish emphasis and varying meanings to verbal language. Thus, by pausing at the proper place and using the proper pitch inflection a sentence like, "Woman without her man is a beast" can be spoken so that the listener understands it to mean something about a woman's need for a man, or with different pauses and inflections to imply that it means something about man's need for woman (Borman, et al, 1969, p. 140). Because visual stimuli are absent, telephoned messages are heavily dependent upon pauses, inflections, and the quality of the voice.

A symbolic movement or gesture such as a nod or

a wink, a facial expression, the posture and body movement of the communicator, the development of the body muscles, and the appearance of the person revealed by the clothing and hairdress - all of these are means which convey information. Although gestures and facial expressions are filtered out of messages transmitted by telephone or radio, they are a part of face-to-face interaction. The person who sits slouched in his chair at a meeting, doodling on the pad before him, apparently unaware of the discussion, is sending a nonverbal message to the others. As with vocal inflections, the receiver tends to believe the gesture rather than the word. If a person leans his face in his hand with a sigh and says with a bored expression, "I am very excited about the new line," his listeners are not likely to believe him.

For the purposes of this study, interpersonal communication between organizations, initiated and accomplished through research scientists and engineers, was viewed and examined in terms of four channels: written correspondence, teletype/telegram messages, telephone conversations, and face-to-face interaction. The term and concept of "richness of communication" was used in conjunction with and to describe and analyze the four different interpersonal channels. Richness of communica-

tion pertains to, basically, two characteristics of the interpersonal communication channels. First, it relates to the technical and mathematical capacities inherent in the four channels. This characteristic includes the limits of symbol transmission, the speed by which the channel can transmit and exchange information, the technical capacities, noise to signal and distortion ratios, number of coding processes available, and the mathematical capacities not concerned with meaning. The second inherent characteristic relates to the capability of the channel to communicate true meaning. This includes the feedback capabilities, the ability to separate unintended meaning and cognition from the intended meaning, and the capability to attain co-orientation and perfect correspondence between sender and receiver. Together, these two capabilities or characteristics form a discriminate measure of richness of communication.

Examining the four interpersonal channels investigated in this study by ranking them on a scale of increasing richness, the lowest or least rich channel would be written correspondence or memoranda. And in the sequence of increasing richness, the channels would be teletype/telegram messages, telephone conversations, and face-to-face interaction; with the face-to-face channel

being the richest of the four. In Part IV, these four interpersonal channels will be examined utilizing this richness concept, and investigating the relationship of richness to the variables of project problems, uncertainties, and varying project conditions.

Theoretical Framework for Concept of Richness

Linguistics has shown that the three principal elements of a language are the phoneme (sounds), morpheme (words), and syntax (patterns or grammar). Sounds are limited in number, whereas words are limited only by the possible patterned combinations of sounds. By themselves, words are neutral. In patterns or grammar, on the other hand, words take on all sorts of more complex types of meanings (Fodor, Jenkins, Saporta, 1967). The language of a message, then, is a set of signals that must be perceived by the receiver on the reception of the incoming signals and evaluated, which also involves memory and the retention of past experiences as well as decision making. The sender of a written correspondence or a teletype message codifies a set of symbols by only one codification system (written language) and is unable to instantaneously validate the interpretation of his message and the different meanings that words can take in various contexts.

The shortcomings of this type of single codification has been studied by semanticists in their concern with the meaning of words in various contexts. Hayakawa (1964) and Rapoport (1962) have stated that meanings of language are semantic reactions that take place in people. A language is therefore not just the sounds and the spellings, but more importantly the whole repertory of semantic reactions which the sounds and spellings produce in those who speak and understand the language. The semanticist goes further than the Aristotelian logician. To him words and assertions have meaning only if they are related to the operational experiences of the referents. In other words, communication between coding systems, without complete knowledge on the part of the communicators of the other's coding system, introduces the reality that part of the semantic-information content of the message will be lost, as Cherry (1957) relates:

The semantic-information content of a statement (which includes all that is logically implicit in that statement) is available only insofar as the rules of the language system are known. (p.236).

The written correspondence and the teletype/telegram channels, with only one codification system available, therefore, are not as rich a channel as those with multiple coding and instantaneous feedback systems available. Teletype/telegram channels are, however, richer than ordi-

nary written correspondence or memoranda because of the speed capacity of the channel and capability to exchange feedback at a faster rate.

Verbal communication, however, does have multiple coding and feedback systems which add meaning and capacity efficiency (richness) to these channels. Variations in vocal inflection, loudness patterns, and the rate of speech are an integral part of the verbal communication process. Receivers of a verbal message can interpret and validate the sender's sincerity, intent, emotion, and attitude from clues contained in the way the words are spoken. Often, receivers believe the manner rather than the matter. It is not difficult, in the course of a telephone conversation, to say, "You should see my new office spaces, wow!" in such a way that the receiver may interpret the message as meaning: The sender thinks the new office is especially spacious and luxurious. Nor is it difficult to say the very same words in such a way that the receiver decided the sender thinks the new office is extremely small or unsuitable to work in.

These qualities of verbal communication have been studied extensively by descriptive linguists. They believe that there are identifiable vocal phenomena that accompany the stream of speech, which, because of a limited

or unique distribution, cannot be analyzed as being part of the phonemic or morphological structure of language. The systematic observation of these phenomena has led to their classification as paralanguage - or voice quality and vocalization. This classification represents the sender's control of the overall or background characteristics of the voice. This would include the sender's control of articulation, tempo, intensity, quantity, pitch height, and pitch range. When any of these is used in amounts differing from normal, the receiver is quite aware that something unusual has occurred (Markel, 1963, p. 232).

The advantages of verbal communication over written channels have been recognized by writers throughout the years. Isocrates declared...."none of the things that are done with intelligence are done without the aid of speech"; and Francis Bacon stated often that...."it is better to deal by speech than by letter". When a person has expressed an idea in words to another, a reaction is necessarily expected. And this reaction contributes to clarify, extend, or alter the original idea. This instantaneous reaction between the sender and the receiver is not possible in written correspondence or teletype messages but is possible in telephone conversa-

tions and face-to-face interactions. Feedback, therefore, refers to the process of correction through incorporation of information about effects achieved. When a person perceives the results produced by his own actions, the information so derived will influence subsequent actions. Feedback of information thus becomes a steering device upon which learning and the correction of errors and misunderstandings are based (Weiner, 1948, 1950).

The advantages of instantaneous feedback, available only through the verbal and face-to-face channels, have been studied and suggested by semioticians. The process of updating involves feedback which relates representation and reality. When an event X is not immediately available for purposes of updating reference, when feedback is delayed, there is obviously a source of potential and serious disabling with respect to achieving solutions for error control problems and, therefore, the resolution of the goal attainment problem (Brissey and Hills, 1969, pp. 98-99). Similarly, a disabling condition can characterize a collaborative system when the semiotic process involved in sharing representations delays reciprocal "map-matching". When the sender and the receiver are neither in simultaneous confrontation with an event X nor are they in simultaneous confrontation

with each other, the conditions are present for delays in both types of feedback.

In verbal communication channels, then, almost continuous feedback is possible and desirable. The sender can never know enough about the moment-to-moment reactions of his receiver. Consequently, he becomes a feedback "detective", sensitive to all clues that tell him how the receiver is reacting. In addition to continuous monitoring of the receiver, the sender is able to continually modify the message. Even the intent, what the sender thought he could accomplish, may need to be revised in light of the receiver's reaction. The context, encoding, and transmission operations are all candidates for modification to better meet the needs of particular receivers. Borman, et al (1969) found that:

Delayed feedback, collecting information about response after the communication is complete, is useful to the planning of future messages, but too late to help a given communication event. Obviously, building continuous feedback mechanisms into a unit of communication becomes exceedingly important (p.30).

Delayed feedback is all that is available in written correspondence, with the delay shortened by the exchange of teletype messages. Continuous feedback is available in the richer verbal communication channels - telephone conversations and face-to-face interaction, respectively.

The mathematical communication discipline has additionally shown that meaning and effectiveness are inevitably restricted by the theoretical limits of accuracy in symbol transmission. The efficiency and effectiveness of a communication system are a function of the amount of information, the capacity of the communication channel, the coding process that may be used to change a message into a signal and the effects of noise or distortion. Writing is a symbolization of a symbolization. When people talk they are using arbitrary vocal symbols to describe something that has happened or might have happened and there is no necessary connection between these symbolizations and what actually occurred. Sentences can be meaningless by themselves. Other symbols may be much more eloquent. By simply raising the pitch of the voice at the end of an utterance instead of letting it fade away or by changing the inflection and intensity of the tone of voice, it is possible to change a statement of fact to a question, or a statement of accordance to one of ire and anger. (Shannon and Weaver, 1949). It has been shown, then, that the limits of symbol transmission, capacity of the communication channel and the number of coding processes available increase as the communication goes from the written message channel to the telephone

conversation channel to face-to-face interaction channel (to richer channels).

The areas of psychology, psychiatry, anthropology and sociology have all contributed to the significance that a person's behavior, action, culture and organizational activity play in the communicative process. Freud (1923) relied heavily on the communicative significance of man's actions rather than his words. He distrusted the spoken word, and a good deal of his thinking was based on the assumption that words hid much more than they revealed. The observance of face-to-face interaction revealed innumerable more than the transmission of a man's words - either written or spoken.

When a person observes a series of events and then wishes to make a statement about them, such a statement has to be represented by signs that are comprehensible to others. The technical aspects of this process are referred to as codification (Ruesch, 1953). In human interaction the most frequent codification systems are: personal appearance and dress, gestures, expressions, behavior, body movement - nonverbal codification; and simple sounds, spoken words - verbal codification. In short, people communicate by making statements. These statements are signals that are coded in various prearranged

ways. When they impinge upon earlier impressions, they become signs. These signs, in the strictest sense of the word, exist only in the minds of people, because their interpretation is based upon prior agreements. A statement becomes a message when it has been perceived and interpreted by another person. Finally, when sender and receiver can consensually validate an interpretation, then communication has been successful (Reusch, 1956).

Signs, then, can be verbal or nonverbal. For the signs to be comprehensible - perceived and interpreted, they must be discriminable. The concept of discriminative stimuli was first proposed by Newcomb (1953) in his description of a communicative act:

Every communicative act is viewed as a transmission of information, consisting of discriminative stimuli, from a source to a recipient. For present purposes it is assumed that the discriminative have a discriminable object as referent. Thus, in the simplest possible communicative act, one person (A) transmits information to another person (B) about something (X) (p. 393).

Given this description of the communicative act, the "message" consists of some behavior on the part of A which can serve as a discriminative stimulus for B but which also has some other source of discriminative stimuli (object X) as referent. Thus if B is to be "informed" by A's behavior, B is required to respond discriminately both to the behavior of A and to the object which is taken as

the referent. Morris (1964) contends that any discriminable event can function as a sign. His analysis holds up for events that are usually thought of as nonlinguistic or nonverbal, as well as verbal events.

Hall (1959) relates that the most elaborate form of interaction is talking with another person face-to-face, which is reinforced by tone of voice, gesture, and behavior or actions. In addition to what men say with their verbal language, they are constantly communicating their real feelings in their "silent language" - the language of behavior. In other words, what people do is frequently more important than what they say. Birdwhistell (1967) also has found that a person's behavior, as revealed by body motion and action (kinesics) is as important a member of the communication system as linguistics is. He states that men have not communicated with each other by language any more than they have lived by metabolism. Speech contributed to the total communication process, but body motion is an important and vital aspect of the total process.

The relationship between face-to-face interpersonal interaction (verbal and non-verbal codification) and telephone or written interpersonal interaction (verbal codification) has been conceptualized by both anthropolo-

gists and psychologists/psychiatrists. Hall (1959), Goffman (1959), Hymes (1967) and Birdwhistell (1967) have all discussed the "out-of-awareness" aspects of communication. A person must never assume that he is fully aware of what he verbally communicates to someone else. There exists tremendous distortions in meaning as men try to verbally communicate to someone else or with one another. A person communicates his real feelings not only with the verbal language, but with his actions and behavior.

Ruesch (1956), Rokeach (1960), and McLeod (1967) have found that verbal language is based upon entirely different principles than the nonverbal language. The use of words, whether in speech or writing, has certain limitations akin to those of the digital computers; words remain identifying or typifying symbols that usually lack the impelling immediacy of analogic devices. Nonverbal communication utilizes analogic codification devices, i.e., they constitute a series of symbols that in their proportions and relations are similar to the thing, or idea, or event for which they stand. Thus, when a statement is phrased verbally, instructions tend to be given nonverbally. When observed simultaneously, they supplement each other and are integrated into functional unity. Thus telephone

conversations are not as rich a channel as face-to-face interpersonal action, but richer than teletype and written channels.

Katz and Kahn (1965) have extended the theory of codification and use of verbal and nonverbal communication (informal/interpersonal channels) from individuals to organizations:

Individuals, groups, and organizations share a general characteristic which must be recognized as a major determinant of communication: the coding process. Any system which is the recipient of information, whether it be an individual or an organization, has a characteristic coding process, a limited set of coding categories to which it assimilates the information received. Organizations too, have their own coding systems which determine the amount and type of information they receive from the external world and the transformation of it according to their own systemic properties. All members of an organization are affected by the fact that they occupy a common organizational space in contrast to those who are not members. By passing the boundary and becoming a functioning member of the organization, the person takes on some of the coding system of the organization. The boundary condition is thus responsible for the dilemma that the person within the system cannot perceive things and communicate about them in the same way an outsider would. If a person is within a system, he sees its operations differently than if he were on the outside looking in (pp. 227-228).

The difficulty presented in inter-organizational communication by the different coding systems of the transacting organizations relates directly to the previous findings showing the increased use of both verbal and nonverbal

communication channels (richer channels) by individuals to overcome coding and symbol constraints between one another.

User Studies Related to Richness of Communication Concept

The previous section developed a theoretical background and framework for the concept of richness of communication as applied to the four interpersonal communication channels that were examined in this study. This section discusses some of the relevant "user" studies related to the richness of the interpersonal channels. As was pointed out in Chapter Two, these "user" studies show the communication patterns and behavior of individual scientists and engineers. These studies all suggest that scientists and engineers consider face-to-face communication as the most important aid to communication, telephone conversations less useful than face-to-face interaction, but substantially more important than the written channels.

Taylor (1962) noted that individuals seem to be able to separate signal from noise in oral or verbal communication better (on a short-term basis) than in written communication. Graham and Zavala (1967) sampled 107 Chairmen of university science departments, Directors of industrial laboratories, and Directors of laboratories

of the federal government and found that individuals cannot easily transmit their impressions and emotional commitments to an idea by using formal means of communication. Such personal commitments are important to scientists and engineers. There is much to be gained from the reactions of others with whom one communicates about science and technology. A direct answer to a question or idea may not be forthcoming, but a raised eyebrow or a narrow squint can indicate an emotional response that is important (p. 40).

Telephone calls were recognized in a study by Zavala and Graham (1967), as a major means to have a dialogue on an idea. A telephone call can immediately settle a letter of inquiry that might otherwise be passed through many hands at much waste of time (p.53). Graham (1967) found that when tables, charts, diagrams, or parts must be involved in a research discussion, the telephone is inadequate. Visual stimuli are needed in order to communicate with the detail and precision required by research scientists and engineers. However, the telephone was seen as one of the most effective and inexpensive means of enhancing research through informal communicators, but administrative restrictions often exist on use of the telephone communications network.

The telephone was reported to be most effective as a substitute for expensive long distance travel. Under conditions of emergency restrictions on travel funds, long distance telephone service was seen as even more vital to research progress than during normal times (p. 156).

In a study of the social psychology of informal communications among scientists, Freedle, et al (1967) found that the telephone is considered one of the best means of communicating, and the expense is not deemed important when critical problems are involved. When a new problem arises, a telephone call can produce required information in a few minutes that could otherwise take days of individual research. They also found that most scientists prefer to call rather than write since it would take three times as long to obtain information without the telephone. Other scientists compared the use of the telephone with travel. Travel is considered to be the most important aid to communication because there is direct contact with other researchers. Telephone conversations are considered to be substantially less useful than travel (face-to-face interaction) (p. 38).

Zavala and Graham (1967) also found that travel was considered to be the most important aid to communica-

tion, because there is direct contact with other researchers, and that the telephone was considered the next most useful channel (p. 54). One researcher interviewed stated the need for face-to-face interaction as follows:

An engineer frequently needs to see what the person is doing with whom he is holding a discussion on the telephone, such as when there is a question about a problem, or an analysis that needs to be written to be understood (p. 97).

These studies have particular relevance to this dissertation because they not only show a definite preference by researchers for face-to-face channels over telephone conversations, and telephone conversations over the written messages or correspondence; but that this need and preference is intensified when critical problems are involved or arise. This related directly to this study in that the four interpersonal channels were examined under varying project conditions, problems, and uncertainties. Table 3-1 shows the percentages of mentions by scientists and engineers, pertaining to choice of communication channels used in obtaining difficult information. Table 3-1 is from a study by Graham and Wagner (1967). The data in the table show that the face-to-face interpersonal channels - totaling direct contact conversations, meetings and conferences, and

Table 3-1

Examples of How Informal Methods Brought Scientists
And Engineers Information That Was Difficult To Obtain

Sample, N = 326 Research Managers and Research Leaders

<u>Informal Methods</u>	<u>Percent</u>
Conversation (direct face to face contact)	56
Meetings and conferences	19
Visiting	17
Telephone	17
Consultation	16
Letter	8
Newsletters	3
Trade journal ads	2
Vendors	<1
Visiting lecturer	<1

Source: Graham and Wagner, 1967

visiting - was mentioned 82 percent, telephone 17 percent, and letters 8 percent.

In a speech, J. Robert Oppenheimer once remarked, "If you really want to communicate, send a man". This statement is exemplified by the above user studies of individual scientists and engineers which suggest that face-to-face interaction is the most important communication channel, and is preferred to telephone conversations, which in turn are preferred over teletype messages and written correspondence. This is in very close correspondence with the findings of Parker, et al (1968) who found that research productivity is increased by interpersonal contact among researchers, and that the best prediction of research productivity was the utilization of travel, telephone calls, and written correspondence, respectively (p. 45).

The final literature examined and reviewed was not a user study, but a historical study of the communication practice and behavior of businesses in the modern world. Bormann, et al (1969), discuss the increasing importance and use of verbal communication by modern business organizations. By 1960, they state that the Gutenberg era had drawn to an end. During this era, businesses had placed an increasingly amount of importance

on written communication and that the business communication slogan was "Never say it, write it". However, by 1960 the amount of paperwork was increasing at an almost exponential rate and it was literally choking business communications. Businesses had learned that paper is seldom the right medium for the communication of action, the "getting-things-done" types of messages that revolve the wheels of industry. In today's rapidly paced business world, written communication had become the slowest, most expensive, and frequently the least effective means of transmitting information. The written word gave ground, then, to the verbal means of communicating. As Bormann, et al state:

The timing of verbal communication can be critically controlled to a degree not possible in written discourse. Again, the face-to-face situation gives the talker clues for determining the proper instant to pursue his point. Written messages can be disastrously timed; they run the risk of reception at exactly the wrong moment (pp. 15-17).

Summary

A framework and background was presented in this chapter from which the four interpersonal communication channels can be examined in the remainder of this dissertation. This chapter introduced a concept of "richness of communication" and showed its relationship to the four interpersonal channels of face-to-face interaction, telephone conversations, teletype/telegram messages, and written

correspondence. It was shown, by both a theoretical development and a review of the user studies of individual scientists and engineers, that richness relates to the technical and mathematical capacities inherent in the interpersonal channels and in the inherent capabilities of the channels to communicate true meaning. Together, these two capabilities and capacities were said to form a discriminate measure of richness of communication. Examining the four interpersonal channels investigated in this study by ranking them on a scale of decreasing richness, the richest channel would be face-to-face interaction; with telephone conversations less rich but richer than teletype and written messages, and teletype/telegram messages less rich than telephone conversations but richer than written correspondence. Written correspondence is the lowest or least rich channel of the four.

PART III
RESEARCH DESIGN AND METHODOLOGY

PART III

RESEARCH DESIGN AND METHODOLOGY

Specifically, this study sought to answer the following questions about the process of inter-organizational communication under varying project conditions:

1. Is the frequency of interpersonal communication channel utilization between project organizations a function of the different and varying kinds of project uncertainties?
2. Does the determinability and complexity of products or services between the transacting project organizations relate to the frequency and utilization of the interpersonal communication channels?
3. Is the interpersonal channel utilization between project organizations related to the nature and characteristics of prior inter-organizational relationships?

The three chapters of Part III have as their coordinate goals the translation of these questions into a set of testable propositions and a description of the research methodology by which these propositions will be tested.

Chapter Four introduces a central or basic hypothesis and three supporting hypotheses based on the framework developed in Chapters Two and Three. Again, interpersonal communication is differentiated into four channels: written correspondence, teletype/telegram messages, telephone conversations, and face-to-face interactions. The richness of communication concept, applied to these four channels, will be used as a variable in the investigation of inter-organizational communication.

Chapter Five discusses the basic research design and methodology in detail. Considerable attention is given to the concept intended for measurement, to techniques for its measurement, and to the nature and characteristics of the types of data and measurement items used in this design. The chapter concludes with a brief discussion of the statistical means and methods used in analyzing the research results.

Chapter Six, the final chapter of Part III, is devoted to a discussion of the two projects and the respective organizations that comprise the sample for this study. The characteristics of the sample considered to be of most interest and the sampling technique are also presented.

CHAPTER FOUR

HYPOTHESES FOR A STUDY OF THE UTILIZATION OF INTERPERSONAL COMMUNICATION CHANNELS IN THE INTER-ORGANIZATIONAL COMMUNICATION PROCESS

Based on the background of research findings on communication behavior of research scientists and engineers presented in Chapter Two and the framework of the capacities and capabilities of the four interpersonal communication channels developed in Chapter Three, a set of hypotheses for the study of interpersonal channel utilization between transacting organizations engaged in research and development projects under varying project conditions was developed. This set of hypotheses includes one central or basic hypothesis from which was developed three supporting hypotheses.

Central or Basic Hypothesis

The central or basic hypothesis that this study examined was:

Interpersonal communication channel usage between the transacting organizations engaged in a research and development project is a function of project uncertainties. That is, interpersonal communication channel utilization between the transacting organizations as measured by frequency, volume, and richness of channel, will vary directly with the degree of project uncertainties.

The interpersonal or informal communication chan-

nels that were measured and examined in this study are:

1. Face-to-face interactions.
2. Telephone conversations.
3. Teletype/telegram messages.
4. Written correspondence.

The frequency of channel utilization pertains to the number of usage instances of each of the interpersonal communication channels over a specified period of time. For the purpose of this study, the frequency was measured by the number of instances of each of the channels per week.

The volume of channel utilization pertains to the total number of usage instances of any of the four interpersonal communication channels over the length of the project. Total volume was taken as the sum of the number of instances of communication of the four channels for an individual project transacting organization.

The richness of communication channels relates to the technical and mathematical capacities inherent in each of the four interpersonal channels and in the inherent capabilities of each of the channels to communicate true meaning. Together, these two capabilities and capacities form a measure of richness of communication. Chapter Three presented a detailed derivation of this

concept. On a scale of richness, the channel with the greatest capacity and capability to communicate (the richest channel) is face-to-face interactions; and, in a descending order of richness: telephone conversations, teletype/telegram messages, and written correspondence.

Three types of research and development project uncertainties were examined in this study. These three types of uncertainties were considered as the independent variables in the measurement of the utilization of the interpersonal communication channels between project personnel of the transacting organizations. Although three types of uncertainties were identified and delineated separately, it was recognized that there is an indirect relationship between the three types as they are all uncertainties arising from a common research and development project. The relevant project uncertainties that were examined and included in this study are:

1. The uncertainties arising as a result of unforeseen technical, budgetary, administrative, and contractual project problems -- this set of uncertainties arises from research and design problems and critical situations which occur during the life of any research and development project. This type of uncertainty includes such problems as a scientific or engineering

research/design enigma or a situation arising from what appears to be a technical impasse; a situation or problem which requires one-of-a-kind or untested technology and methods; a budgetary or cost constraint requiring certain aspects or phases of a project be completed with less/more manpower, material, or funds than were originally planned and scheduled for; or an unplanned acceleration or slippage in the project requiring the formulation of a new timeframe and scheduling reference with its associated probabilities of on-time project completion.

2. Product or service uncertainties -- this type of uncertainty relates to the extent to which a product or service is determinable or of a routine nature. A research and development project requires products and services which range from very routine, catalogue, highly determinable in nature to those products and services which are one-of-a-kind, never before developed, non-routine and difficult to determine in nature.

3. Inter-organizational relationship uncertainties -- this type of uncertainty pertains to the characteristics of the relationships between the project personnel of the prime contractor and the key research personnel of the various sub-contractors and the monitoring/sponsoring organization. These characteristics

include the length and nature of the relationship between transacting organizations such as a first business transaction or contract between organizations, or the research and development reputation and general business reliability of the organizations.

Supporting Hypotheses

The central or basic hypothesis described above is a general hypothesis with several dependent and independent variables. In order to facilitate and simplify the examination, delineation, and testing of this hypothesis, three supporting hypotheses were developed. These supporting hypotheses were all derived from the central hypothesis and tested in order to provide support or non-support of the central hypothesis.

The dependent variable in all three of the supporting hypotheses is the utilization of the interpersonal communication channels between the transacting project organizations. This variable was measured by the collection and examination of non-reaction or unobtrusive measures (Webb, Campbell, Schwartz and Sechrest, 1966). A detailed discussion of this type of measurement is presented in Chapter Five, Research Methodology. The frequency of channel utilization per week was collected from the organization's clerical/administrative records and

displayed by means of simple graphic methods.

The user studies of individual scientists and engineers and the concept of richness derived from human communication theory suggest that the utilization of the interpersonal communication channels between project personnel of the transacting organizations is related to the varying project conditions and problems - the project uncertainties. The supporting hypotheses, therefore, are as follows:

- SH-1. Interpersonal communication channel utilization between the transacting organizations is a function of uncertainties arising from project problems such as: unforeseen or unexpected technical, budgetary, administrative, and contractual problems. It is expected that channel utilization will increase with the occurrence of any one of these types of problems, and that there will be, concurrently, an increased use of the richer channels of communication.

The research project manager and the key project scientists and engineers of the prime organization and, if applicable, the sponsoring/monitoring organization were interviewed in order to construct a project history or record. These interviews supplemented the recorded preplanned and contract scheduled pert milestone/cost plans; and, most importantly they were used to identify and describe the project uncertainties arising from technical, budgetary, administrative, and contractual problems.

This included identification, by specific dates, of the recognized beginning and termination of the above types of project uncertainties. These identified time frames of uncertainty, then, formed the independent variable used for testing the first supporting hypothesis. This variable was compared and evaluated with respect to the frequency of each separate interpersonal communication channel (dependent variable) with the aid of methods described in detail in Chapter Five.

SH-2. Interpersonal communication channel utilization between the transacting organizations is a function of the variation in determinability and complexity of products or services. It is expected that for a non-routine, one-of-a-kind, underterminable product or service, the volume, frequency, and richness of communication channels will be higher than for a routine, catalogue, or highly determinable product or service.

The dependent variable was the same as that utilized for the first supporting hypothesis except for the additional measure of volume. Not only was frequency and richness of communication channels examined, but also the total amount of interpersonal communication between the prime organization and a sub-contractor organization. These measures were then compared and evaluated against the same measures drawn from the channel utilization data of the prime organization and a different sub-contractor

organization of the same project. The differences between the channel utilization behavior of these organizations were then compared and related to the independent variable - determinability or complexity of product or service.

To evaluate the variation in the uncertainty of determinability and complexity of products or services, members of the prime organization were interviewed concerning the product or service rendered by a sub-contractor organization and asked the following question:

1. A dichotimization might be made concerning the determinability and complexity of products or services rendered by the sub-contractor. How would you describe this variable along the following spectrum?

Routine,
Determinable,
Catalogue item

One-of-a-kind
Non-routine,
Undeterminable

1 2 3 4 5 6 7

The third and last supporting hypothesis relates channel utilization to inter-organizational relationship uncertainties.

- SH-3. Interpersonal communication channel utilization between the transacting organizations is a function of the nature and length of the inter-organizational relationships between the project personnel

of the prime organization and the various sub-contractor organizations. It is expected that a prior established relationship of excellent business reliability and practices will result in lower volume, frequency, and richness of communication channels.

The dependent variable, again, was the same as that of the second supporting hypothesis. These measures were previously discussed. Again, the differences between the channel utilization behavior of the prime organization and a sub-contractor organization and the prime organization and a different sub-contractor organization of a common project were related to the independent variable of inter-organizational relationships.

To evaluate these relationships, members of the prime organization were interviewed concerning inter-organizational relationships with sub-contractor organizations and asked the following questions:

1. To what extent have you had prior business transactions with the sub-contractor organization?

Numerous prior transactions, a well established prior relationship

First business transaction, no prior relationship

1 2 3 4 5 6 7

2. A rough dichotimization might be made concern-

ing the business practices and reliability of the sub-contractor organization. How would you describe this variable along the following spectrum?

Excellent business
practices and
reliability

Poor business
practices and
reliability

1 2 3 4 5 6 7

In chapters Seven and Eight, these supporting hypotheses relating to interpersonal communication channel utilization are examined. In these chapters hypotheses are analyzed and tested in conjunction with the data collected, and any additional insights the data might provide are discussed. The next chapter, Chapter Five, describes the research methodology used in this study.

CHAPTER FIVE

RESEARCH DESIGN AND METHODS

We must use all available weapons of attack, face our problems realistically and not retreat to the land of fashionable sterility, learn to sweat over our data with an admixture of judgement and intuitive rumination, and accept the usefulness of particular data even when the level of analysis available for them is markedly below that available for other data in the empirical area.

(Binder, 1964, p. 294)

Research Design

Festinger and Katz (1953) consider three basic designs suitable for research in the behavioral sciences: the sample survey, the controlled experiment, and the field or natural study (pp. 13-172). This study was basically a natural study, an approach that has often been employed to study organizational patterns in their setting. The second approach above, controlled experiment or some version of it, is often favored by researchers because it is especially suited to permit inferences about causality and the testing of causal hypotheses. However, it is sometimes difficult to place an organization in the controlled experiment; and the more complex the organization or with the addition of other organizations, the more difficult this approach becomes. Experimentation, therefore, often is not possible because of the

inability of the investigator to control all the factors in a situation.

The nature of the measurement techniques used and the nature of the sample and research setting of this study, did not facilitate or allow the use of the controlled experiment approach. Two different research and development projects were investigated in this research. Both projects involved a prime contractor organization and several sub-contractor and technical supplier organizations, had been in various phases of development for over a year, and were on critical preplanned and scheduled PERT milestones/cost plans. These factors and characteristics of the projects and the transacting organizations did not permit the direct or indirect control of the variables in this study. The essence of a controlled experiment is the comparison of two situations that are identical in all respects except that some factor (X) is introduced in one situation but not in the other. It requires the actual manipulating of some conditions in the existing organizations for the purpose of determining causal relations.

The conditions under which the projects investigated in this study were performed and the complex nature of the projects studied eliminate the feasibility of the type of manipulation used in a controlled experiment. A

natural experimental approach, however, does not require that the investigator manipulate or control some factor (X) but allows the investigator to observe changes and contrasting relationships that occur or have occurred during the period being examined. The natural research design approach was, therefore, employed in this study and the impact of on-going changes in interpersonal channel utilization and the varying project uncertainties was investigated. In his discussion of experiments in this type of design setting, French (1953) points out that....."in the natural experiment, the investigator does not himself manipulate certain factors within the research setting, but he opportunistically capitalizes upon some on-going changes and studies their effects in an experimental design" (p. 99).

There are other practical advantages to the use of the field or natural research design. Blau and Scott (1962) relate that the field or natural study is the typical research design employed in the study of complex organizational functions and that this design is particularly hospitable to the combined use of a variety of data-gathering methods, including direct observation, interviewing, and the analysis of documents and records (p. 20). This advantage is crucial, for it enables the

selection of those research methods that are considered the most appropriate for the study of a given problem. The research methods utilized in this study were a combination of analysis of documents/records and interviewing. These research methods are discussed in detail in the next section.

The field or natural research design, then, was considered the most appropriate approach and best suited for this study. Because the variables cannot be manipulated as in a controlled experiment, this study investigated the on-going changes of channel utilization and project uncertainties between transacting project organizations. As Blau and Scott (1962) state:

Although the field study does not approach the controlled experiment in rigor of design and hence in validity of conclusions, the use it permits of a combination of systematic research procedures concentrated on a single object of study can yield data of considerable scientific value. Moreover, its focus on social relations among individuals and groups in natural settings provides data of great importance for the study of organizations - data of a type not obtained by any other design. (p. 21).

Another aspect of the research design is the specific purpose for which the data are collected. Selltitz et al (1964) classify studies in broad groupings of research purposes:

1. To gain familiarity with a phenomenon or to

achieve new insights into it, often in order to formulate a more precise research problem or to develop hypotheses.

2. To portray accurately the characteristics of a particular individual, situation or group (with or without specific initial hypotheses about the nature of these characteristics).
3. To determine the frequency with which something occurs or with which it is associated with something else (usually, but not always with a specific initial hypothesis).
4. To test a hypothesis of a causal relationship between variables (p. 50).

Studies that have the first purpose listed above are generally called exploratory studies. Studies with the second and third purposes are called descriptive studies, and those with the fourth purpose are called hypothesis - testing studies. In practice, these different types of study are not always sharply distinguishable. Many studies have a mixed purpose and have elements of two or more of the above functions. The present study had such a mixed purpose. It was descriptive when the characteristics and history of the projects and inter-organizational communication patterns were recounted; it

was hypothesis testing when the specific propositions described in the previous chapter were tested; and it was exploratory when an attempt was made to achieve new insights and propose implications for future research studies.

Research Methods

The literature on research methodology normally classifies research methods according to the techniques employed in the collection of data. In principle there are three ways of obtaining information about organizational communication behavior: by watching the members of the transacting organizations, by asking them questions, and by examining materials that have been written by them. The three categories of research techniques which correspond to these operations are: observation, interviewing, and the analysis of documents. One group of these techniques may be used to the exclusion of the others, or a study may combine all three approaches.

Webb et al (1969) relate that today, the dominant mass of social science research is based upon interviews and questionnaires. They lament this overdependence upon a single, fallible method...."interviews and questionnaires intrude as a foreign element into the social setting they would describe, they create as well as measure

attitudes, they elicit atypical roles and responses, they are limited to those who are accessible and will cooperate, and the responses obtained are produced in part by dimensions of individual differences irrelevant to the topic at hand" (p. 1). The principle objection raised is that interviews and questionnaires are used alone. No research method is without bias. If interviews and questionnaires are used, they should be supplemented by other research methods that have different methodological weaknesses.

The use of multiple research methods overcomes the objections to a single class of data collection; and if that single class is the questionnaire or interview, multiple methods reduce the potential sources of error known as "reactive measurement effects". Shils (1959) identified such reactive effects as: the simulation of warmth by the interviewer to insure rapport, and giving the appearance of agreement to answers on controversial questions to encourage the expression of unpopular attitudes. These reactive effects decrease the internal validity of a comparison - the confidence that a true difference is being observed. Webb et al (1969) strongly urge the use of multiple research methods, not to replace the interview, but to supplement and cross-validate

it with measures that do not require the cooperation of a respondent and that do not themselves contaminate the response (p. 2).

To reduce the potential errors or bias of a single class of data collection and to take advantage of the "natural resources" made available by a field or natural study, this study utilized the multiple research method. The dependent variable - frequency of interpersonal channel utilization - was measured by the collection and analysis of the prime contractor organization's documents and records. This method of research data collection is known as unobtrusive or non-reactive measurement. This was a systematic analysis of the organization's documents and records by using methods of content analysis to establish the frequency and volume with which interpersonal communication channels were utilized. The independent variable - project uncertainties - was measured and collected by use of standardized interviews with the research project manager and key project personnel of the prime organizations.

Unobtrusive Measurements¹

The unobtrusive field - measurement data of the

¹These are nonreactive measures such as the use of archival records and trace measurements which serve to avoid problems of invasion of privacy by permitting the researcher to gain valuable information without identifying the individual actors or in any way manipulating them.

dependent variable was obtained from the clerical/administrative documents and records of the prime contractor organization. A particular advantage of this technique of data collection was precisely the existence of such documents and records; to overlook their significance as an inexpensive, valuable source of data on the communication behavior of the transacting organizations and the conduct of their respective research leaders and key personnel was to fail to exploit the "natural resources" available for this study. The unobtrusive data collected and gathered from the prime organization of each of the two projects included only project inter-organizational information and communication usage records which relate to the utilization of the four interpersonal communication channels.

A data recording form was used to record the frequency of each of the four channels per week by project and by organizations. A copy of this form is included in Appendix A. The frequency and volume of the written correspondence channel was obtained from the project written correspondence files of the prime organization. These files included the number of outgoing and incoming instances of written communication and the identification of the transacting organizations. A copy of all outgoing

and incoming teletype or telegram messages was kept in the clerical files by both of the prime organizations concerned with the two separate projects that were used in this study. The files showed the date and the sender/receiver organization of each message; and examination of the record files permitted accurate recording of the utilization of this interpersonal channel.

The measurement and recording of the telephone conversation channel was accomplished by examining the telephone message files of each of the prime contractor organizations. Fortunately, for the investigator, both prime organizations had required that all incoming and outgoing calls between transacting organizations be recorded on a telephone conversation form. Information included on these forms were date, place, time, names of the organization personnel who were participants in the conversation, and a brief statement of content of the conversation. These telephone conversation forms were filed by project and organization in the prime organization's administrative/clerical records.

Face-to-face meetings between project personnel of the prime organization and the sub-contractor organizations or monitoring/sponsoring organization were recorded by examining the travel voucher records and the

security register of the prime organizations. The project travel vouchers revealed the dates, times and organizations visited by personnel of the prime organization. The security register log revealed the dates, times, and names of transacting organization personnel visiting the prime organization and the names of the prime organization personnel being visited. Combining the data of both of these records, permitted the complete recording of face-to-face communication channel.

The use of unobtrusive measurement techniques in recording the utilization of the four interpersonal communication channels had several advantages over other research method techniques. One was the low cost of acquiring a large amount of pertinent data, another was its nonreactivity. The problems of invasion of privacy were avoided by permitting the investigator to gain valuable information without manipulating the individual actors. The gain in nonreactivity was important because it compensated for the reactivity which is inherent in the interviews discussed in the next section. As Selltiz et al (1964) suggest:

Data collected in the course of routine or normal activities have a number of advantages in social research, in addition to that of economy. A major one is the fact that much information of this sort is collected periodically, thus making possible this establishment of trends over time.

Another is that the gathering of information from such sources does not require the cooperation of the individuals about whom information is being sought, as does the use of questionnaires, interviews, and frequently observation. Moreover, since, such data are collected in the ordinary course of events, the measurements procedure is less likely to change the behavior in which he is interested than are some of the other data collection techniques (pp. 316-317).

Interview Methods

All variables are not amenable, however, to study by unobtrusive measures. Such is the case in the collection of data to examine and measure the independent variables of this study. The first supporting hypothesis required that the independent variable of project uncertainties be identified and described. This was accomplished by bringing the project manager and key project personnel of the prime organization together as a small group, and interviewing them by means of a schedule standardized interview (Richardson et al, 1965, pp. 34-38). This type of interview was most useful when information was desired on the range and variety of problems confronted by the organization and its members. These key project leaders were asked to describe and relate the history of the research project from its beginning to the time of the study and to both identify and describe in detail all project uncertainties arising from technical, budgetary,

administrative, and contractual problems - to identify and describe any event or situation that was "unexpected" or "out-of-the-ordinary". When an uncertain period was identified, the group was asked to consensually agree on the approximate date when the uncertain event or situation was first recognized and when the period of uncertainty was recognized as being over.

The second and third supporting hypotheses required that the independent variables of determinability of products or services and inter-organizational relationships be identified on an ordinal scale of measurement in order to facilitate their comparison with the differences between the dependent variables of two subcontractor organizations. An ordinal scale defines the relative position of objects or individuals with respect to a characteristic, with no implication as to the interval between positions. The basic requirement for an ordinal scale is that one be able to determine, for each individual or object being measured, whether that individual has more of the attribute in question than another individual, or the same amount, or less; in other words, one must be able to determine the order of position (Selltitz et al, 1964, p. 191). Again, as with the first supporting hypothesis, the group of key project personnel

of the prime organization were interviewed by means of a schedule standardized interview and asked three questions, each to be answered by employing three respective graphic rating scales coded on a 1 to 7 basis. These questions and scales were delineated in detail in Chapter Four. The graphic rating scale was widely employed because of its simplicity of use and because it provides opportunity for as fine discrimination as that of which the rater was capable (Guilford, 1954). These scales provided an ordinal measurement of the independent of the second and third supporting hypotheses.

The techniques of research methodology used in this study, then, were both unobtrusive measurements and interviewing - the multiple method approach. This was considered the most practical method as it relies on unobtrusive measure for the dependent variables and interviewing measures for the independent variables. Through the use of the multiple method approach, the internal validity of the comparisons was furthered - the confidence that a true difference was being observed.

Statistical Analyses

Statistical testing of hypotheses was limited to nonparametric statistical tests which are uniquely suited to the data of the behavioral sciences. These tests

provide a method of testing hypotheses which does not require the parametric test conditions that: the observations be drawn from normally distributed populations, the populations have the same variance, and the variables involved must have been measured in at least an interval scale.

The distributions of the frequency and volume of each interpersonal channel were not tested to determine homoscedasticity and normal distribution nor was an assumption of an interval scale made. The section on interview methods above has already discussed the measurement of the independent variables in an ordinal scale. Therefore, the hypotheses testing in this study was limited to nonparametric techniques.

Siegel (1956) aptly stated the use of nonparametric methods when concerned with the problem of statistical inference:

More recently we have seen the development of a large number of techniques of inference which do not make numerous or stringent assumptions about parameters. These newer distribution free or nonparametric techniques result in conclusions which require fewer qualifications. Having used one of them, we may say that "Regardless of the shape of the population(s), we may conclude that" (p. 3).

In this dissertation the dependent variable in all three supporting hypotheses - frequency and volume of

the interpersonal communication channels - was displayed in a series of statistical graphic forms, histograms. In the case of Supporting Hypothesis One, the independent variables (project uncertainties) were plotted on the horizontal time axis showing beginning and ending times of relevant uncertainties. The simplicity and clarity of the results found in the graphs emphasized important facts and relationships that did not require sophisticated statistical testing methods. This is also true in the case of the second and third supporting hypotheses.

However, a Kolmogorov - Smirnov one sample test was used to test and determine if an observed increase in magnitude of frequency of a channel during a designated time period was likely on the basis of chance. That is, the sampling distribution indicates whether a divergence of the observed magnitude would probably occur if the observations were really a random sample from a theoretical uniform distribution. This nonparametric test of goodness of fit is a more powerful test than the Chi Square Test because of the small sample involved.

In this test the null hypothesis is that the observed distribution comes from a population that has a uniform distribution and that the observed magnitudes of frequency are not important. If the probability that the null hypothesis is correct is shown to be less than

p or $\alpha = 0.05$, the null hypothesis is rejected. In this case the alternate hypothesis is accepted that a statistically significant difference exists between the observed distribution and the theoretical uniform distribution - in this case the observed magnitudes of frequency during a specified time period are important and not likely on the basis of chance. A detailed discussion of this test is described in Siegel (1956, pp. 47-52) and Clark and Schkade (1969, pp. 436-441).

To aid in analyzing the change in frequency magnitudes between the four channels during periods designated as uncertain periods, simple numerical percentages were used. Each individual communication channel, of the collected data of communication channel utilization between the prime organization and a transacting organization, was examined separately. For example, a period of uncertainty was designated and the average amount of face-to-face communication was computed for this period. Then the average amount of face-to-face communication during periods of certainty was computed, and the percentage increase in this channel between periods of certainty and uncertainty was computed. In turn, the other three channels' percentage increases during the period of uncertainty were computed, and then, the per-

centage increases (or decreases) of all four channels could be compared against one another. In this manner, the richness of communication concept in relation to periods of uncertainty could be examined and analyzed.

As was mentioned previously, the simplicity and clarity of the results of the graphic presentation of the data for all three supporting hypotheses emphasizes results and relationships that normally did not require statistical testing and analyses. In the case of the first supporting hypothesis, the Kolmogorav - Smirnov test and simple percentages were utilized to aid in the interpretation of the graphic presentations.

CHAPTER SIX

THE SAMPLE

The data for this study were obtained from the prime organizations of two separate research and development projects. The two projects were selected by purposive, nonprobability sampling procedures (Chein, 1964, pp. 509-545) from a restricted population. This sampling procedure was used because of the special needs and inherent project conditions required by the research design and by the research measurement methods. The use of both interviewing and unobtrusive measurement techniques in the collection of data necessitated the investigation of projects which maintained detailed, accurate, thorough, and complete records and files of interpersonal communication behavior between the prime organization and the various transacting organizations. The research design, additionally, called for the comparison of interpersonal communication channel utilization of two prime project organizations with diverse or dissimilar specified characteristics. These characteristics were in size (in dollar cost) of projects, basic goal orientation of the prime organizations, and physical location of the prime organizations with regard to total communication accessibility.

These special needs, requirements, and characteristics restricted the population of research and development projects from which the sample could be drawn and resulted in a specific list of criteria for the selection of the two projects and their respective prime organizations. This list of criteria contained the following list of specifications:

1. The prime organizations of the two projects should have on file sufficient records and documents to fulfill the unobtrusive measurement requirements of the four interpersonal communication channels.

2. One of the projects sampled should be a project of comparatively small dollar cost size, and the second project should be a project of comparatively large dollar cost size.

3. The prime organization of one project should be a profit oriented organization, and the prime organization of the second project should be a non-profit organization.

4. The total communication accessibility of the two prime organizations should be different. One prime organization should be located in or near a transportation and communication center, while the second prime organization should be located in an area which is not

on the major transportation and communication arteries.

5. Each project should consist of one prime organization and at least three vendor or sub-contractor organizations.

A pretest of the desirability and feasibility of the criteria for the selection of projects and the capabilities of research and development organizations to furnish the data required by the design of the study was accomplished by interviewing the manager of a research and development division of a large industrial corporation.

The research manager stated that many industrial research and development organizations working on non-military projects did not maintain files and records in sufficient detail to meet the unobtrusive measurement requirements of the utilization of the four interpersonal communication channels. This was especially relevant in the measurement of incoming telephone conversations and visits made to the prime organization by vendor and sub-contractor organization personnel. Therefore, in order to meet the requirements of criterion 1, it was decided the two projects sampled would be projects sponsored and funded by the Department of Defense and would be of a classified nature. The documents and records that Defense

Department contracts require be initiated and maintained on classified research and development projects are of sufficient detail and thoroughness to provide the data required for unobtrusive measurement of the interpersonal communication channels.

The interview also revealed that projects of a relative small dollar cost size often result in a very small amount of inter-organizational communication because of a combination of meager dollar amounts of sub-contracts and number of vendor or sub-contractor organizations. By contrast, research and development projects of a very large dollar amount or cost size often result in a preponderance and magnitude of inter-organizational communication that would make the collection and analysis of data a longitudinal and uneconomical, if not improbable, research effort. Therefore, it was decided the two projects sampled should be between the one to ten million dollar amount or cost size.

Two research and development projects were selected which were able to furnish the data required by the research design and methodology. The remainder of this chapter describes the characteristics of and the significant differences between the two prime organizations and the respective projects sampled.

The first project, hereafter designated Project Alpha, was a research and development project sponsored and funded by one of the major services of the Department of Defense and consisted of the development of a completely new and radically different electronic weapons system. This project was not just a sophisticated extension or a more advanced design of a previous developed system, but consisted of both research and development activities and phases to develop a new concept and state-of-the-art in a specialized field of electronic systems and equipment. The project was highly classified and, as such, came under the stringent security regulations, requirements and directives of the Department of Defense.

The cost of Project Alpha was originally placed at 3.4 million dollars but because of increased costs and variances from planned expenditures, an overrun increased the total project cost to 5.5 million dollars. This included the conceptual research and design, the development and testing of one experimental model, and the fabricating and testing of two developmental models of the electronic system.

The prime organization of Project Alpha was a division of an industrial corporation which is one of the worlds largest developers and manufacturers of elec-

tronic equipment, for both military and non-military use. The research and development division (organization), from which all the data of this project was collected, was located in a large metropolitan area which is one of the major transportation and communication centers of the United States. The prime organization, hereafter designated as Alpha or A, had a staff of 25 electrical engineers, 2 mechanical engineers, 2 physicists and 15 technicians. The project manager, his assistant, and 3 members of the staff had master degrees in electrical engineering. The remaining engineers and scientists all had bachelor degrees.

The prime organization A awarded contracts and purchase orders to three major sub-contractor or vendor organizations, designated as A_1 , A_2 , and A_3 . All three vendor organizations supplied vital and critical components to the project and were awarded purchase orders in the following dollar amounts:

A_1	\$179,000
A_2	\$110,000
A_3	\$ 53,000

In addition, the defense monitoring agency, designated A_m , contributed to a substantial amount of inter-organizational communication. Therefore, the data collected

from the prime organization A of Project Alpha was analyzed and interpreted to reveal the inter-organizational communication channel utilization between the prime organization A, and the transacting organizations A_1 , A_2 , A_3 and A_m .

The second project, hereafter designated Project Bravo, was also a research and development project sponsored and funded by one of the major services of the Department of Defense and consisted of the development of a technically sophisticated and highly advanced acoustical electronic detection system. Project Bravo was a classified project and was required to maintain security procedures and records in accordance with Defense Department Security and Contract Administration regulations.

Project Bravo was programmed and contracted for a total cost of 1.3 million dollars and has incurred no overrun costs. The project contract included the basic design and mount steady, the fabrication of four developmental models, and the testing and evaluation of the four developmental models.

The prime organization of Project Bravo was a division of a non-profit organization formed to work in specialized areas for the public welfare and national security of the United States. The work performed in

this research and development division primarily involved the performance of basic and applied research and its application in the areas of acoustical and electro-magnetic waves to the development of electronic detection systems and equipment for the Department of Defense. The prime organization (research and development division), from which all the data of Project Bravo was collected was located in a relatively small metropolitan area which is neither a communication or transportation center. From the air transportation aspect, the area is relatively inaccessible.

The prime organization, hereafter designated as Bravo or B, had a staff of 3 physicists with master degrees, 2 mechanical engineers (1 master and 1 bachelor degree), 4 electrical engineers (1 master and 3 bachelor degrees), 5 full time technicians and 6 part time technicians. The project manager and his assistants both had master degrees. The prime organization B also awarded contracts and purchase orders to three major sub-contractor or vendor organizations, designated as B_1 , B_2 , and B_3 . All three sub-contractor organizations supplied critical and major components to the project and were awarded purchase orders in the following dollar amounts:

B_1

\$100,000

B_2	\$61,000
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B_3	\$26,000
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Therefore, the data collected from the prime organization B of Project Bravo were analyzed and interpreted to reveal the inter-organizational communication channel utilization between the prime organization B and the transacting sub-organizations B_1 , B_2 , and B_3 .

PART IV

ANALYSIS AND EXAMINATION OF INTERPERSONAL COMMUNICATION
CHANNEL BEHAVIOR OF THE TRANSACTING ORGANIZATIONS OF TWO
RESEARCH AND DEVELOPMENT PROJECTS

PART IV

ANALYSIS AND EXAMINATION OF INTERPERSONAL COMMUNICATION CHANNEL BEHAVIOR OF THE TRANSACTING ORGANIZATIONS OF TWO RESEARCH AND DEVELOPMENT PROJECTS

Chapters Seven and Eight together comprise Part IV, which describes the interpersonal communication channel utilization between transacting organizations as a function of uncertainties and analyzes the supporting hypotheses of Chapter Four.

Chapter Seven explores the question: Is the utilization of interpersonal communication channels between the prime organization and the sub organizations of a research and development project a function of uncertainties arising from unforeseen or unexpected project problems? Project conditions and frequency of channel utilization are measured and analyzed in detail. Supporting Hypothesis One is presented and tested by three different measures of interpersonal channel utilization: (1) correlation between periods of uncertainty and increased frequency of utilization of the interpersonal channels, (2) average weekly frequency of utilization of the individual channels of the transacting sets of organizations during periods of uncertainty and periods of

certainty, and (3) the percentage increases in utilization of the individual channels during periods of uncertainty. The evaluation of the testing is presented and a discussion of the interesting features of the results of the analysis concludes the chapter.

Chapter Eight explores two different questions: (1) Does the determinability and complexity of products or services between the transacting project organizations relate to the utilization of the interpersonal channels? (2) Is Interpersonal channel utilization between project organizations related to the nature and characteristics of inter-organizational relationships? These two types of uncertainties or factors are measured and the data related to these factors are analyzed in terms of the utilization of the interpersonal communication channels. Supporting Hypotheses Two and Three are presented and tested by three measures of channel utilization similar to those of Chapter Seven. The implications of some non-model factors or variables which appear to be influential and affect channel utilization are identified and discussed.

CHAPTER SEVEN

INTERPERSONAL COMMUNICATION CHANNEL UTILIZATION BETWEEN TRANSACTIONING ORGANIZATIONS AS A FUNCTION OF UNCERTAINTIES ARISING FROM UNFORESEEN PROJECT PROBLEMS

Introduction

Is the utilization of interpersonal communication channels between the prime organization and the sub organizations of a research and development project a function of uncertainties arising from unforeseen project problems? This question is the basis for the first supporting hypothesis of this study. Changes in utilization of interpersonal channels as a function of project uncertainties were examined in two different contexts. In the first of these contexts, utilization was examined by measuring the frequency of channel usage per week of the four interpersonal channels. Measured channel utilization was between the prime organization and each relevant sub organization. Changes in frequency of each interpersonal channel were compared with the designated periods of project uncertainties; and the differences in frequency of each individual channel during periods of uncertainty and periods of certainty were examined.

In the second context, channel utilization was

examined by measuring the richness usage aspect of each interpersonal channel. In this case, the changes in frequency of each of the four channels during a specific period of uncertainty were compared with one another to examine the differences or similarities in the relative utilization of the interpersonal communication channels.

In the remaining sections of this chapter, the measurement of channel frequency and richness, and the measurement of uncertainties arising from unforeseen project problems are discussed briefly. Then, an analysis is made in which the differences in interpersonal channel utilization associated with differences in project conditions and project organizations are examined. The results of testing Supporting Hypothesis One, which is concerned with the changes in interpersonal channel utilization as a function of project problem uncertainties, are presented and discussed. A summary and general discussion of findings closes the chapter.

Measurement of Varying Project Conditions and Frequency of Channel Usage

As was pointed out in Part III, four interpersonal channels were measured in terms of frequency of communication instances per week by means of unobtrusive records and documents. These four interpersonal channels of

communication were:

1. Face-to-face interaction
2. Telephone conversation
3. Teletype/telegram messages
4. Written correspondence

Each of the two research and development projects examined in this study had different prime organizations. Unobtrusive data was collected from these two prime organizations and channel utilization determined by recording the inter-organizational instances of communication per week between the prime organization and each of the major sub or vendor organizations for each of the four interpersonal communication channels. Project Alpha involved the prime organization A, three major sub organizations A_1 , A_2 , and A_3 , and a monitoring/sponsoring organization A_m . Channel utilization data of each of the four channels was recorded separately for the inter-organizational communication between A and A_1 , A and A_2 , and A and A_3 , and A and A_m . This same recording procedure was used for Project Bravo with the exception that Bravo involved the prime organization B and sub organizations B_1 , B_2 , and B_3 only.

The recorded instances of inter-organizational communication consisted of communication between project

managers and project personnel of the transacting organizations. Form or non-relevant types of business communication between the central billing or purchasing departments of the various transacting organizations was not included in the data collected and recorded. This was the only type of communication between the transacting organizations that was not included in the collection and recording of channel usage.

The project uncertainties that were measured and that are discussed in this chapter were uncertainties arising as a result of project difficulties such as: unforeseen or unexpected technical, budgetary, administrative, or contractual problems. The data were obtained by interviewing the project manager and relevant project personnel of each of the prime organizations A and B, and asking them to both identify and describe in detail all project uncertainties arising from the above unforeseen or unexpected or any out-of-the-ordinary events or situations which occurred. When such an uncertain period was identified, the project group was asked to consensually agree on the week in which the uncertain event or situation was first recognized and when the period of uncertainty was recognized as being over.

The total period of the project being examined

for each set of transacting organizations was then broken down into the designated periods of uncertainty, with the remaining time period designated as the period of certainty. These periods of certainty and uncertainty became the independent variable with which the frequency of channel utilization was compared and analyzed.

Analysis of Interpersonal Channel Utilization

The data obtained through the recording of unobtrusive records and by the interviews of the project managers and personnel of organizations A and B were analyzed in terms of differences in frequency of channel utilization associated with periods of certainty and uncertainty in the specified length of the project life examined. To examine differences in channel utilization as a function of project problem uncertainties, each project's data were analyzed over a specific length or timeframe of the project's life, and then this timeframe was divided into periods of uncertainty, with the remaining periods lumped together as the period of certainty.

The data of Project Alpha were collected for an eighty (80) week timeframe in the life of the project. This timeframe began one month after the contract was officially placed with organization A and continued for eighty consecutive weeks. The frequency of channel uti-

lization between $A \longleftrightarrow A_2$, $A \longleftrightarrow A_3$, and $A \longleftrightarrow A_m$ was recorded in weekly chunks or intervals for the eighty week span. The instances per week of inter-organizational communication between $A \longleftrightarrow A_1$ were recorded for the first thirty-six weeks only of the eighty week timeframe as the contract with A_1 was terminated at the end of the thirty-sixth week.

The data of Project Bravo were recorded as instances of channel utilization per week for a forty (40) week timeframe of the project's life. This timeframe began two months after the basic project design of organization B was approved and continued for forty consecutive weeks. The instances per week of inter-organizational communication between $B \longleftrightarrow B_1$, $B \longleftrightarrow B_2$, and $B \longleftrightarrow B_3$ were all recorded for this forty week timeframe.

The periods designated and identified as periods of uncertainty of Projects Alpha and Bravo are shown in Table 7-1. Data are presented by showing each set of transacting organizations, the inclusive weeks in which the period or periods of uncertainty occurred for that particular set, and the general type and description of the project uncertainty. It is interesting to note that there were sixteen identified periods of uncertainty, of which twelve were identified as being related to technical

TABLE 7-1

PERIODS IN THE TIMESPAN OF A PROJECT DESIGNATED
AS PERIODS OF UNCERTAINTY

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Project	Transacting organizations	Periods of Uncertainty* (Inclusive Weeks)	Type of Uncertainty
ALPHA	$A \longleftrightarrow A_1$	13 through 19	TECHNICAL - Component, Design and Development Problems
		30 through 36	TECHNICAL AND CONTRACTUAL - Contract Terminated With A_1 in 36th Week
	$A \longleftrightarrow A_2$	25 through 27	TECHNICAL - Performance Testing of Major Component
	$A \longleftrightarrow A_3$	8 through 11	TECHNICAL - Component Design Problems
		25 through 27	TECHNICAL - Continued Component Development Problems
	$A \longleftrightarrow A_m$	25 through 28	TECHNICAL - Concerned With Technical Diffi- culties of A_2 and A_3
		33 through 36	TECHNICAL AND CONTRACT- UAL - Cancelling of Contract With A_1
		38 through 41	BUDGETARY - Overrun in Contract of 3.4 to 5.5 Million Dollars
		46 through 53	TECHNICAL AND CONTRACT- UAL - Late Delivery of First Experimental Model

BRAVO	B ↔ B ₁	68 through 72	TECHNICAL - Major Review of Evaluation Tests of First Experimental Model
		16 through 19	TECHNICAL - Component Design Test, Modification Needed
	B ↔ B ₂	3 through 4	TECHNICAL - Late Delivery of Component Due to Technical Problems
		7 through 10	TECHNICAL - Continuing Technical Problems With Component
		19 through 25	TECHNICAL - Tests of Component Unsatisfactory, Modification Required
		27 through 29	TECHNICAL - Performance Test, Modification Required
	B ↔ B ₃	17 through 22	TECHNICAL - Design Test of Component, Modification Required

*Periods identified and designated as periods of uncertainty by project personnel. E.g., the first period of uncertainty for A ↔ A, was identified as originating in week 13 and terminating in week 19 of the project life.

problems. Three of the periods were related to a combination of both technical and contractual problems, and one period was related to a budgetary problem. Fifteen of the sixteen periods of uncertainty were identified as the type of project uncertainty resulting from technical or a combination of technical and contractual problems. It appeared from this limited example that for research and development projects consisting of new concepts and highly advanced technological innovations, the periods of uncertainty that arise are mainly of a technical nature.

Another facet of the data was the average length in weeks of the periods of uncertainty for each project. The periods of uncertainty of Project Alpha had an average length of duration of 4.9 weeks, while the periods of uncertainty of Project Bravo had an average length of 4.3 weeks. It appeared, then, that the average duration of periods of uncertainty of the research and development projects studied was slightly more than 4.5 weeks.

Looking specifically at the subdivisions of Project Alpha, it was noted that the transacting organizations $A \longleftrightarrow A_1$ had a period of uncertainty occurring during the 30th through 36th weeks and that $A \longleftrightarrow A_m$ had a directly related period of uncertainty occurring during the 33rd through 36th weeks. Also $A \longleftrightarrow A_2$ and $A \longleftrightarrow A_3$ had

periods of uncertainty occurring during the 25th through 27th weeks and that $A \longleftrightarrow A_m$ had a period of uncertainty directly related to the problems of A_2 and A_3 occurring during the 25th through 28th weeks. This facet will be examined again in a later part of this chapter.

Having identified and tabulated the periods of uncertainty for each set of transacting organizations, it was then possible to examine the changes in utilization of interpersonal communication channels in the first of the contexts discussed in the introduction to this chapter. Tables 7-2 and 7-3 present the average frequency per week of each interpersonal channel of each set of transacting organizations during the designated periods of uncertainty and during the periods of certainty. In addition, the average frequency of channel utilization for each set of transacting organizations during their respective combined periods of uncertainty is shown. For example, Table 7-1 revealed that two periods of uncertainty were associated with the transacting organizations $A \longleftrightarrow A_1$. Table 7-2 presents these same two periods of uncertainty under the columns \bar{X}_{uc} . The average frequency per week of each interpersonal channel for the two periods of uncertainty is shown under the first two \bar{X}_{uc} columns, respectively. The average frequency per week of

TABLE 7-2

AVERAGE FREQUENCY PER WEEK OF CHANNEL UTILIZATION
DURING PERIODS OF CERTAINTY AND UNCERTAINTY

Sample	Transacting Organizations	Channel	\bar{X}_{uc*}	\bar{X}_{uc*}	\bar{X}_{uc*}	\bar{X}_{uc*}	\bar{X}_{uc**}	\bar{X}_{uc***}
Project Alpha	$A \longleftrightarrow A_1$	F to F	1.14	1.00			1.07	.27
		TC	3.00	1.28			2.14	.55
		T	1.43	.71			1.07	.54
		WC	1.14	.71			.93	.95
	$A \longleftrightarrow A_2$	F to F	.67				.67	.07
		TC	1.67				1.67	.36
		T	.33				.33	.11
		WC	0				0	.16
	$A \longleftrightarrow A_3$	F to F	.50	.67			.57	.05
		TC	1.00	1.33			1.14	.12
		T	0	0			0	.04
		WC	0	0			0	.14
	$A \longleftrightarrow A_m$	F to F	1.75	1.75	2.50	1.63	2.00	.42
		TC	3.25	.75	4.00	1.50	3.00	.82
		T	.25	.25	.50	.38	.20	.18
		WC	1.50	1.25	2.00	2.12	1.40	1.64

\bar{X}_{uc} = Average weekly frequency during periods of uncertainty. F to F = Face to Face

\bar{X}_{uc} = Combined weekly average during periods of uncertainty. TC = Telephone

\bar{X}_{uc} = Average weekly frequency during periods of certainty. T = Conversation

Teletype/
Telegram

Written
Correspondence

TABLE 7-3

AVERAGE FREQUENCY PER WEEK OF CHANNEL UTILIZATION
DURING PERIODS OF CERTAINTY AND UNCERTAINTY

Sample	Transacting Organizations	Channel	\bar{X}_{uc*}	\bar{X}_{uc*}	\bar{X}_{uc*}	$\bar{\bar{X}}_{uc**}$	\bar{X}_{c***}
B	B ₁	F to F	.50			.50	0
		TC	2.75			2.75	.53
		T	.25			.25	0
		WC	.50			.50	.25
Project Bravo	B ₂	F to F	.50	0	.14	.13	0
		TC	3.00	4.50	4.14	4.13	.66
		T	0	.25	0	.06	.04
		WC	.50	1.25	1.00	.88	.33
B	B ₃	F to F	.33			.33	.03
		TC	2.83			2.83	.62
		T					
		WC	1.17			1.17	.27

<u>**Xuc</u>	= Average weekly frequency during periods of uncertainty.	F to F	= Face to Face
<u>**Xuc</u>	= Combined weekly average during periods of uncertainty.	TC	= Telephone
<u>**Xuc</u>	= Average weekly frequency during periods of certainty.	T	= Conversation
			= Teletype/
			Telegram
		WC	= Written
			Correspond-
			ence

each interpersonal channel for the two uncertain periods combined is shown under the column \bar{X}_{uc} . The average frequency per week of the interpersonal channels for the period of certainty is presented under the column \bar{X}_c .

The most distinctive feature of the data in Tables 7-2 and 7-3 was the differences in the frequency of utilization between periods of uncertainty and periods of certainty for the face-to-face and telephone conversation interpersonal communication channels. The average weekly utilization value of the face-to-face channel was greater (in two cases, equal) for individual periods of uncertainty than for periods of certainty for each set of transacting organizations in both Projects Alpha and Bravo. This was also true of the combined average of weekly utilization during periods of uncertainty for the face-to-face channel. Each combined average of periods of uncertainty was greater than the average of periods of certainty of face-to-face channels for every transacting organization of both projects.

The utilization of the telephone conversation channel appeared to be almost the same as that of the face-to-face channel. With the exception of one period of uncertainty of the transacting organization $A \longleftrightarrow A_m$, the average weekly utilization value of the telephone

conversation channel was greater for individual periods of uncertainty than for periods of certainty of each set of transacting organizations in both projects. This exception occurred in the second period of uncertainty of the transacting set $A \longleftrightarrow A_m$. The average weekly value of telephone conversations for this period of uncertainty was .75 while the average weekly value for the period of certainty was slightly higher at .82. The other fifteen periods of uncertainty all had a higher average telephone channel utilization than the respective periods of certainty. This exception did not appear when comparing the differences of combined average values of periods of uncertainty with periods of certainty for the telephone conversation channel. In every set of transacting organizations, the combined weekly utilization average of periods of uncertainty were higher than the weekly utilization averages of periods of certainty for the telephone conversation channel.

The utilization of the telegram/teletype communication channel appeared to follow the consistent trend of the face-to-face and telephone conversation channels. In ten of the sixteen individual periods of uncertainty, average weekly utilization of the teletype/telegram channel was greater during these individual periods of

uncertainty than for periods of certainty. The trans-acting set $B \longleftrightarrow B_3$ had zero utilization of this channel for both periods of uncertainty and certainty, and only five of the sixteen individual periods of uncertainty had average weekly utilization values of the teletype/telegram channel lower than the respective periods of certainty. Two of the five lower values appeared in the transaction set $A \longleftrightarrow A_3$ and the other three appeared in the transaction set $B \longleftrightarrow B_2$. All five of these average weekly values of periods of uncertainty were 0.0 compared with the average weekly value of .04 for the periods of certainty. These differences were slight and appeared to be almost negligible. With the exception of one trans-acting set, the combined weekly averages of utilization of the teletype/telegram channel were greater during periods of certainty. The exception appeared in the transaction set $A \longleftrightarrow A_3$, in which the combined weekly average of utilization was 0.0 compared to the value of .04 for the period of certainty - again a very negligible difference. In general, therefore, it appeared that the frequency of utilization of the teletype/telegram channel followed the pattern of the face-to-face and telephone conversation channels in that the frequency of utilization was greater during periods of uncertainty than during periods of certainty.

The frequency of utilization of the written correspondence channel did not appear to follow the consistent pattern of greater utilization during individual periods of uncertainty that was evidenced by the face-to-face, telephone conversation, and teletype/telegram channels. Nine of the sixteen individual periods of uncertainty had average weekly utilization values that were higher than the average values for periods of certainty, while seven of the sixteen individual periods of uncertainty had lower average weekly utilization values than those for periods of uncertainty. The combined weekly utilization averages indicated the same general trend. In four of the seven sets of transacting organizations, the written communication channel was utilized to a greater extent during periods of uncertainty than during periods of certainty. The data indicated, therefore, that the written channel of communication was used only slightly more during periods of uncertainty than during periods of certainty. However, the differences were generally modest and no consistent pattern of any magnitude was apparent.

With respect to the differences in period utilization between Projects Alpha and Bravo, there appeared to be one distinctive difference. In Project Bravo, all

of the combined weekly averages for periods of uncertainty of each type of channel for each set of transacting organizations were higher than the weekly averages of utilization for periods of certainty. All of the individual periods of uncertainty of Project Bravo also had higher weekly utilization averages than for periods of certainty with the exception of three individual periods. These three exceptions occurred in the same channel (teletype/telegram) and in the same set of transacting organizations ($B \longleftrightarrow B_2$), and the differences in the average weekly values of utilization appeared to be slight. Uncertain periods one, three, and four of the teletype/telegram channel of the set $B \longleftrightarrow B_2$ all had values of 0.0 for the periods of uncertainty, while the weekly utilization value of the period of certainty for the same channel was only slightly above zero at .04.

Comparison with Project Alpha showed that twelve of the sixteen combined weekly averages of utilization for periods of uncertainty of each channel of each set of transacting organizations were higher than the respective weekly averages of utilization for periods of certainty. It is interesting to note that three of the four combined averages of periods of uncertainty which were lower than the periods of certainty occurred in

the utilization of the written channels of communication and the fourth lower combined average occurred in the utilization of the teletype/telegram communication channel of the set $A \longleftrightarrow A_3$. Face-to-face and telephone conversation channels all had higher combined average frequency of utilization values for periods of uncertainty than for periods of certainty.

Considering all the average weekly utilization values of Tables 7-2 and 7-3, the general picture that emerged was one of increasing use of interpersonal communication channels during periods of uncertainty. The data more often than not suggested that average weekly frequency of channel utilization during periods of uncertainty was higher than the average weekly frequency of channel utilization during periods of certainty. This was true for all of the combined weekly averages of periods of uncertainty of Project Bravo and for the majority of the combined weekly averages of periods of uncertainty of Project Alpha. In all cases, the individual periods of uncertainty of the face-to-face channels had higher weekly averages of utilization than the periods of certainty. Fifteen of the sixteen individual periods of uncertainty of the telephone conversation channel had higher weekly averages of utilization than for periods

of certainty. In ten of the sixteen individual periods of uncertainty, average weekly utilization of the teletype/telegram channel was higher during these individual periods of uncertainty than for the periods of certainty. In the majority of the individual periods of uncertainty of the written correspondence channel, average weekly utilization was higher during these individual periods of uncertainty than for the period of certainty. In a few of the individual and combined periods of uncertainty, average weekly utilization was lower than for the periods of certainty; but the majority of these few cases occurred in the written correspondence channel and the differences were very slight. In order to make a better determination of the changes in utilization of interpersonal channels as a function of project uncertainties, this investigation will now examine graphical presentations depicting the changes in utilization.

Figures 7-1 through 7-7 graphically present the data from which Tables 7-2 and 7-3 were extracted. Each graph represents an individual set of transacting organizations and depicts the frequency of utilization of the four interpersonal communication channels associated with the timespan of the project examined and the designated periods of uncertainty. The horizontal axis of

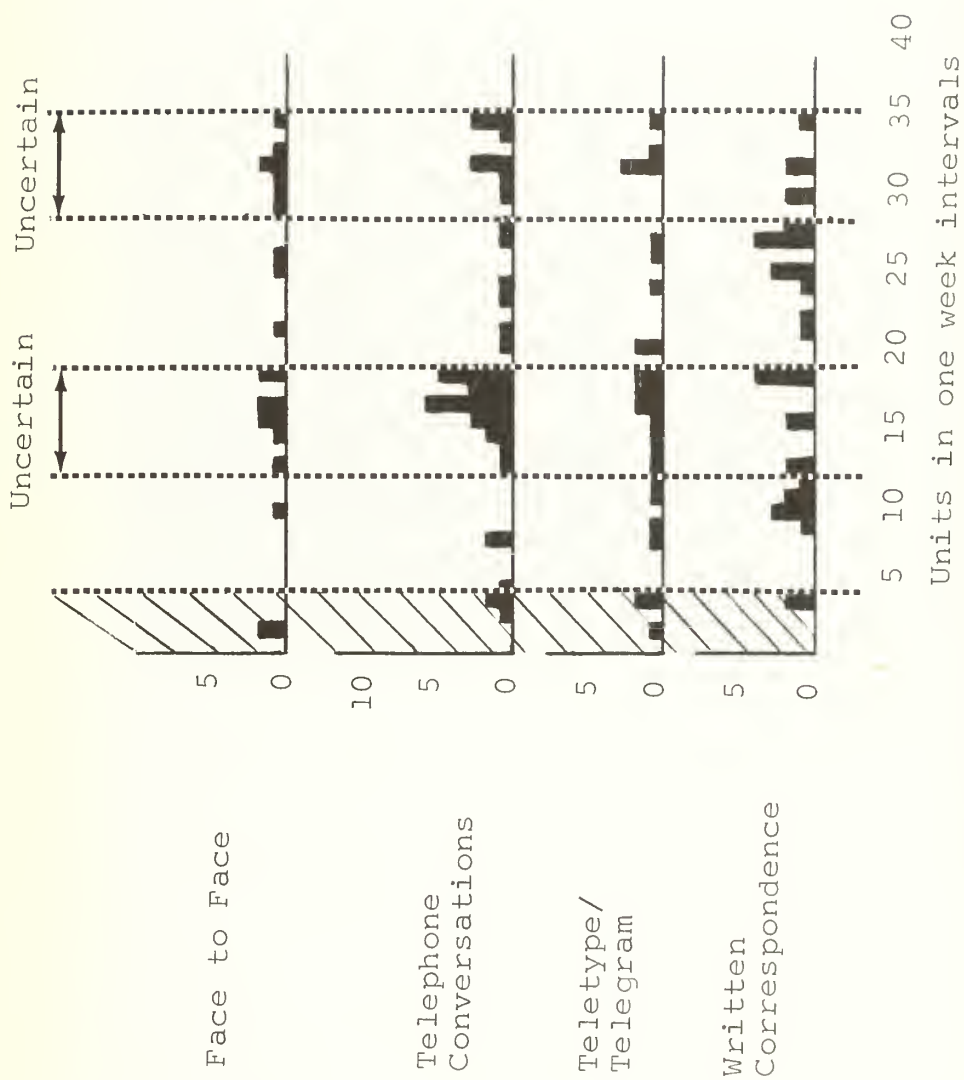
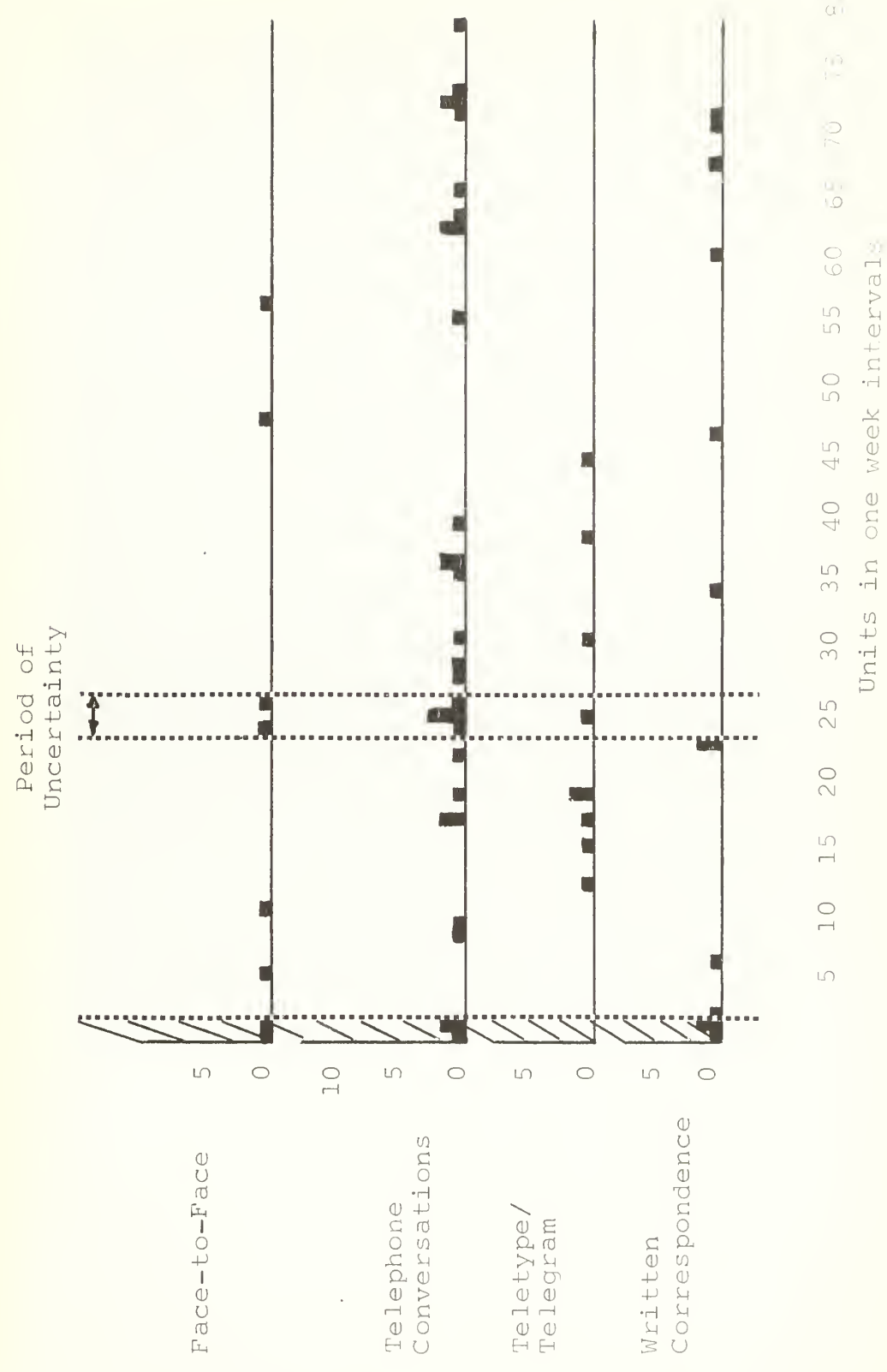


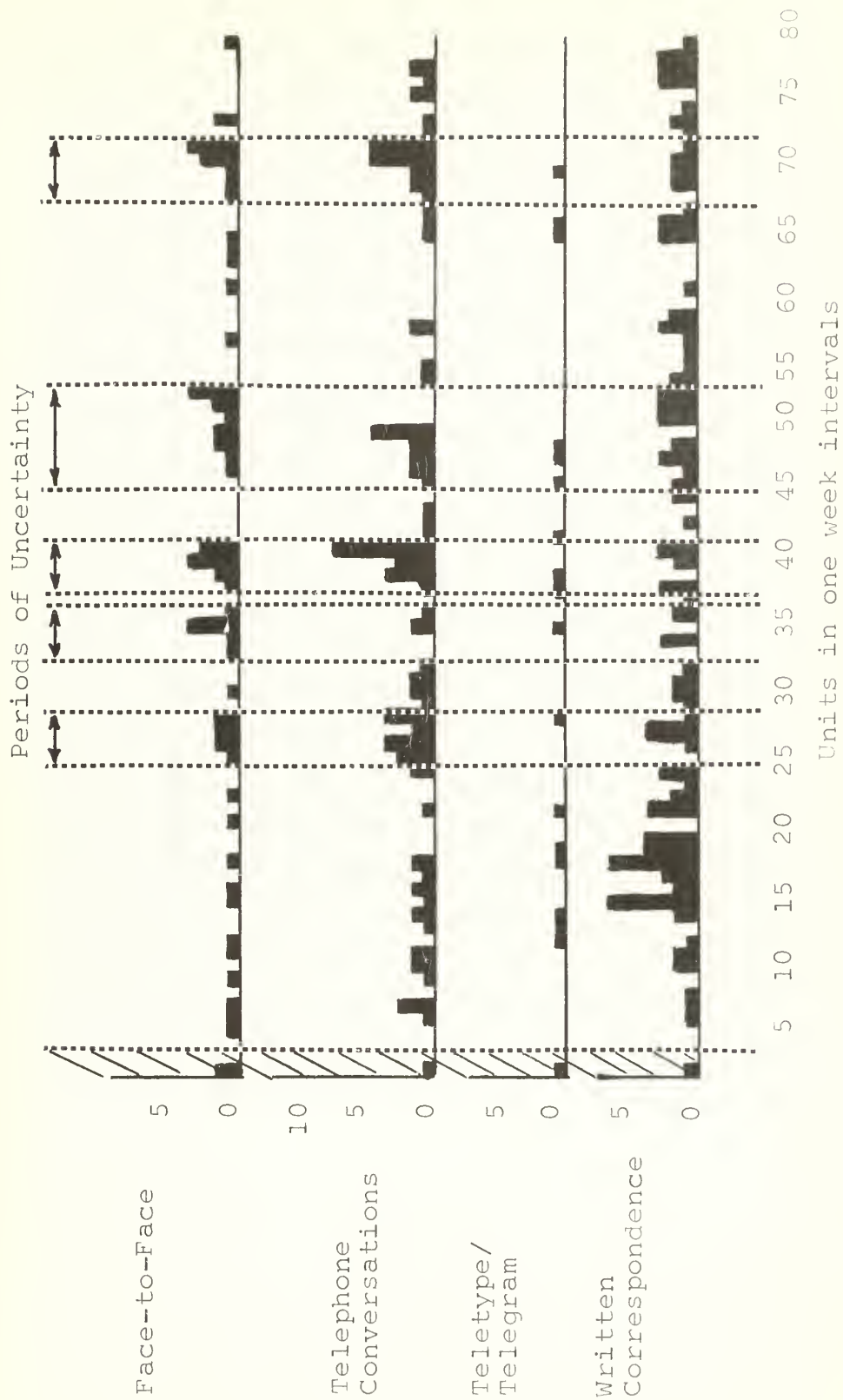
FIGURE 7-2

FREQUENCY OF UTILIZATION OF TRANSMITTING ORGANIZATIONS A \longleftrightarrow A₂



FREQUENCY OF UTILIZATION OF TRANSACTING ORGANIZATIONS $A \leftrightarrow A_3$





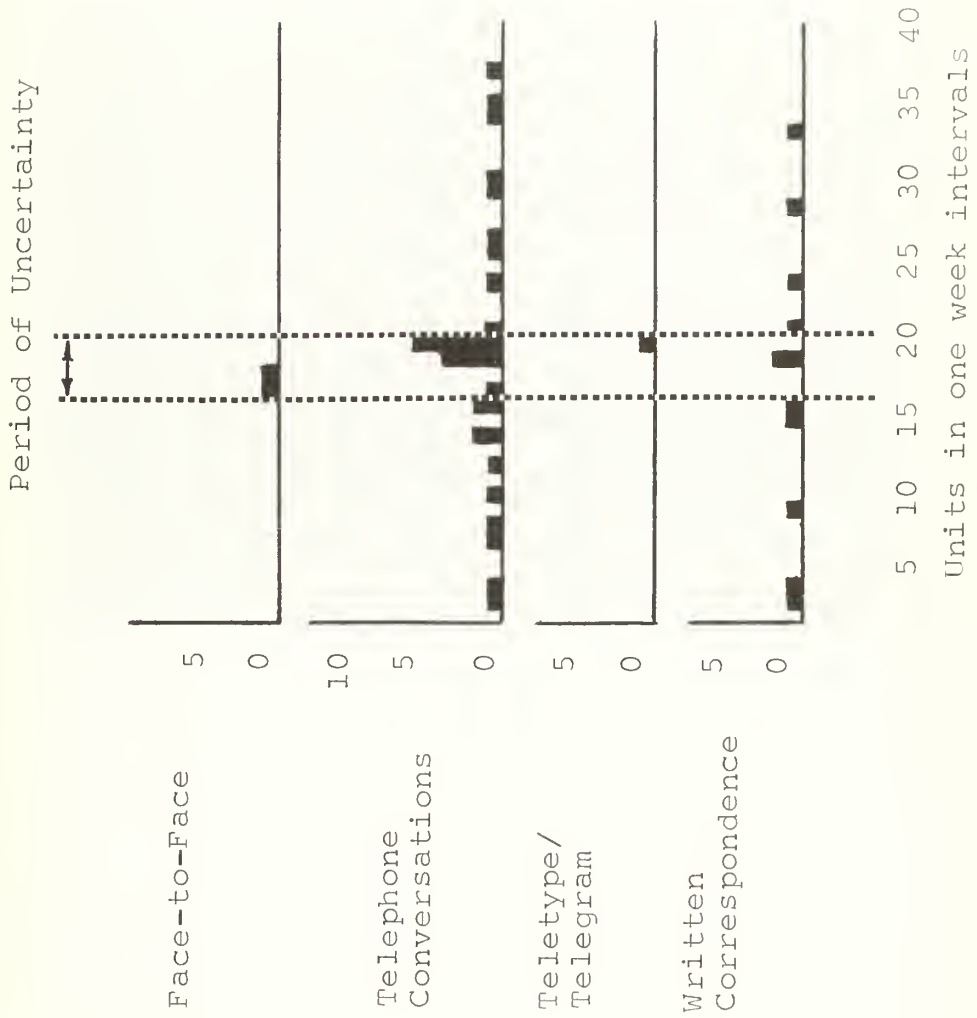


FIGURE 7-6

FREQUENCY OF UTILIZATION OF TRANSACTING ORGANIZATIONS B \longleftrightarrow B₂

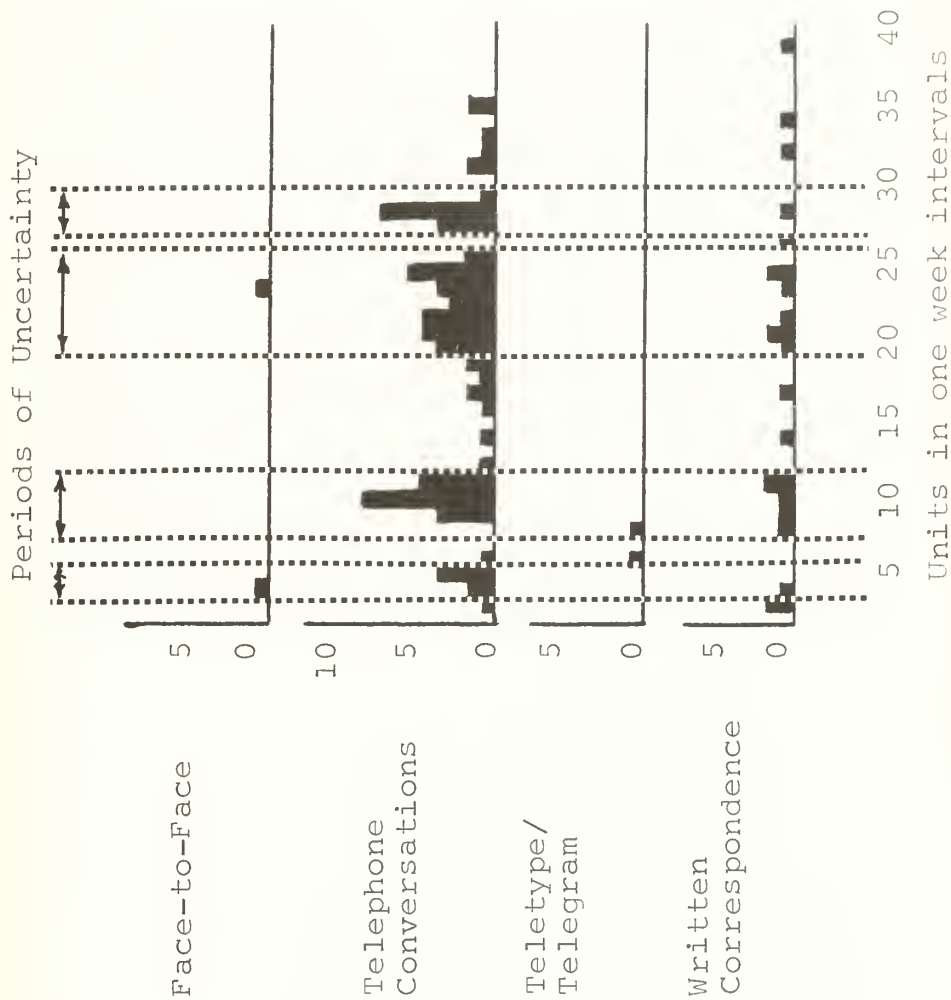
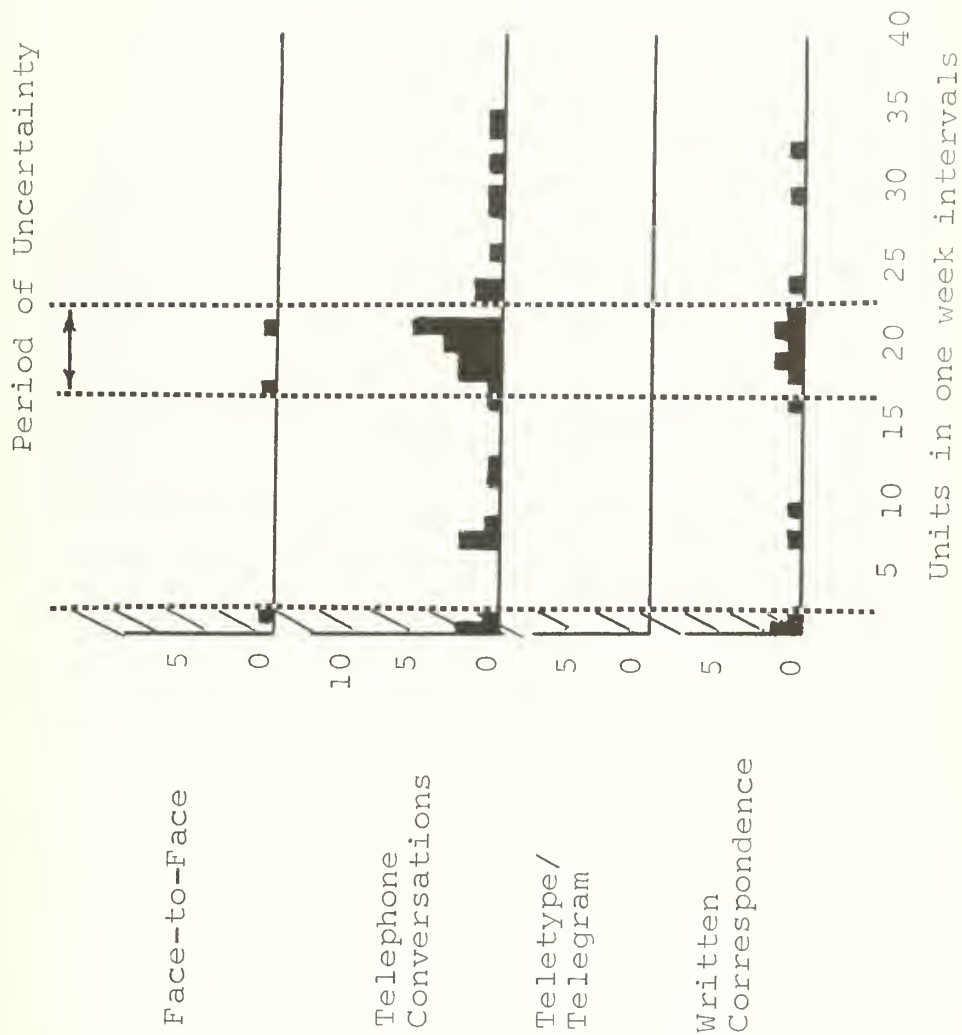


FIGURE 7-7
 FREQUENCY OF UTILIZATION OF TRANSACTING ORGANIZATIONS $B \longleftrightarrow B_3$



the graph is divided into the weeks of the project life investigated. The vertical axis represents the frequency of utilization of the four interpersonal channels for each set of transacting organizations. The vertical dotted lines interposed on the graphs depicts the designated periods of uncertainty for the set of transacting organizations being examined.

Figures 7-1 through 7-4 present the data of the four transacting set of organizations of Project Alpha and Figures 7-5 through 7-7 present the data for the three transacting set of organizations of Project Bravo. The most distinctive feature presented in each graph is the apparent one-to-one correspondence or correlation between periods of uncertainty and increased frequency of utilization of the interpersonal communication channels. Examination of each of the seven graphs visually demonstrates that for every designated period of uncertainty there appeared to be a fairly dramatic overall increase in frequency of utilization of the interpersonal channels for each of the seven sets of transacting organizations. The graphs also indicate that there was no apparent overall increase or rise in frequency of utilization of the channels during any other timeframe or any of the remaining non-identified periods which

were labeled periods of certainty.

There was one exception to these consistent patterns and that was the increase in frequency of utilization of the channels in the first few weeks of all the transacting sets in Project Alpha, and in the first few weeks of the transacting organization set $B \longleftrightarrow B_3$. In Figures 7-1 through 7-4 and in Figure 7-7, there does appear to be an overall increase in frequency of utilization associated with the first few weeks of each graph, and these periods are shown as the diagonal-hatched area on each of these graphs. These specific periods were neither designated periods of uncertainty nor labeled as part of the period of certainty for each set of transacting organizations. Recalling the discussion at the beginning of this section; it was shown that the time-frame for analysis of the four transacting sets of organizations of Project Alpha began approximately one month after the contract was officially placed with prime organization A. Examination of the project history revealed that the first few weeks after the official placing of the contract with A, was the period during which A placed sub-contracts with organizations A_1 , A_2 , and A_3 , and consulted about these sub-contracts with A_m . This is the same period of time represented by the

diagonal-hatched areas covering the first few weeks of Figures 7-1 through 7-4.

It was also shown that the timeframe of analysis of Project Bravo began two months after the basic design of the project system was approved. Examination of the project history revealed that the sub-contracts for B_1 and B_2 were placed before this timeframe, but that the sub-contract for B_3 was placed in the first weeks of the relevant timeframe of analysis of this study; and this period is represented by the diagonal-hatched area of Figure 7-7. While these periods may be viewed as periods of uncertainty, Allen (1966), Rosenbloom and Wolek (1967), and Graham (1967) have all found that there is an increased utilization of all communication channels in research and development projects during the initial life of a project when contracts and design proposals are placed. Their findings appear to be confirmed again by this study. These periods can be labeled periods of uncertainty, but they are expected periods of uncertainty and as such are not relevant to the analysis and examination of this study. The periods of uncertainty relevant to this study were those with uncertainties arising from unforeseen or unexpected project difficulties or problems, and the diagonal-hatched periods of Figures 7-1

through 7-4 and Figure 7-7 are, therefore, not examined separately in this study. The data of each of the four channels during this period, however, were included as part of the general period of certainty, which resulted in a more powerful analysis of data and a larger sample.

Other items of interest of the visual presentations of the graphs include the utilization of the face-to-face and telephone conversation channels during the periods of uncertainty. The most apparent and discernible increases in frequency of utilization during periods of uncertainty of every transacting set occurred in the face-to-face and telephone conversation channels. The teletype channels appeared to have a general increase in utilization during periods of uncertainty, while the written correspondence channel demonstrated no consistent pattern or trend in differences of utilization between periods of uncertainty and periods of certainty. It appeared that the greatest increase in frequency of utilization of the interpersonal channels during periods of uncertainty occurred in the face-to-face and telephone conversation channels, with the teletype channel showing a slight trend in increased utilization and the written correspondence channel demonstrating no apparent pattern or discernible differences between periods.

Another noteworthy facet found in the graphical

presentations is the gradations of increase and decrease in frequency of utilization of the face-to-face and telephone conversation channels during periods of uncertainty. In general, it appeared that there was a gradual increase in frequency of utilization of these two channels in the beginning weeks of the uncertain periods, a peak in the later stages, and then a rapid and sharp decline in frequency of utilization as the periods end. This consistent pattern was in general evidence in all the graphical presentations. It indicates that there was a gradual crescendo rise in the utilization of these two channels as the period of uncertainty was recognized and progressed, it reached a high point, and did not taper off but dropped off rapidly and sharply as the period of uncertainty terminated.

Examination of the individual graphical presentations revealed several interesting possible relationships between the face-to-face and telephone conversation channels during periods of uncertainty. There appeared to be differences in utilization of these two channels in the second (33nd through 36th weeks) and fourth (46th through 53rd weeks) periods of uncertainty in the transacting set $A \longleftrightarrow A_m$ of Figure 7-4. In the second period and the later stages of the fourth period

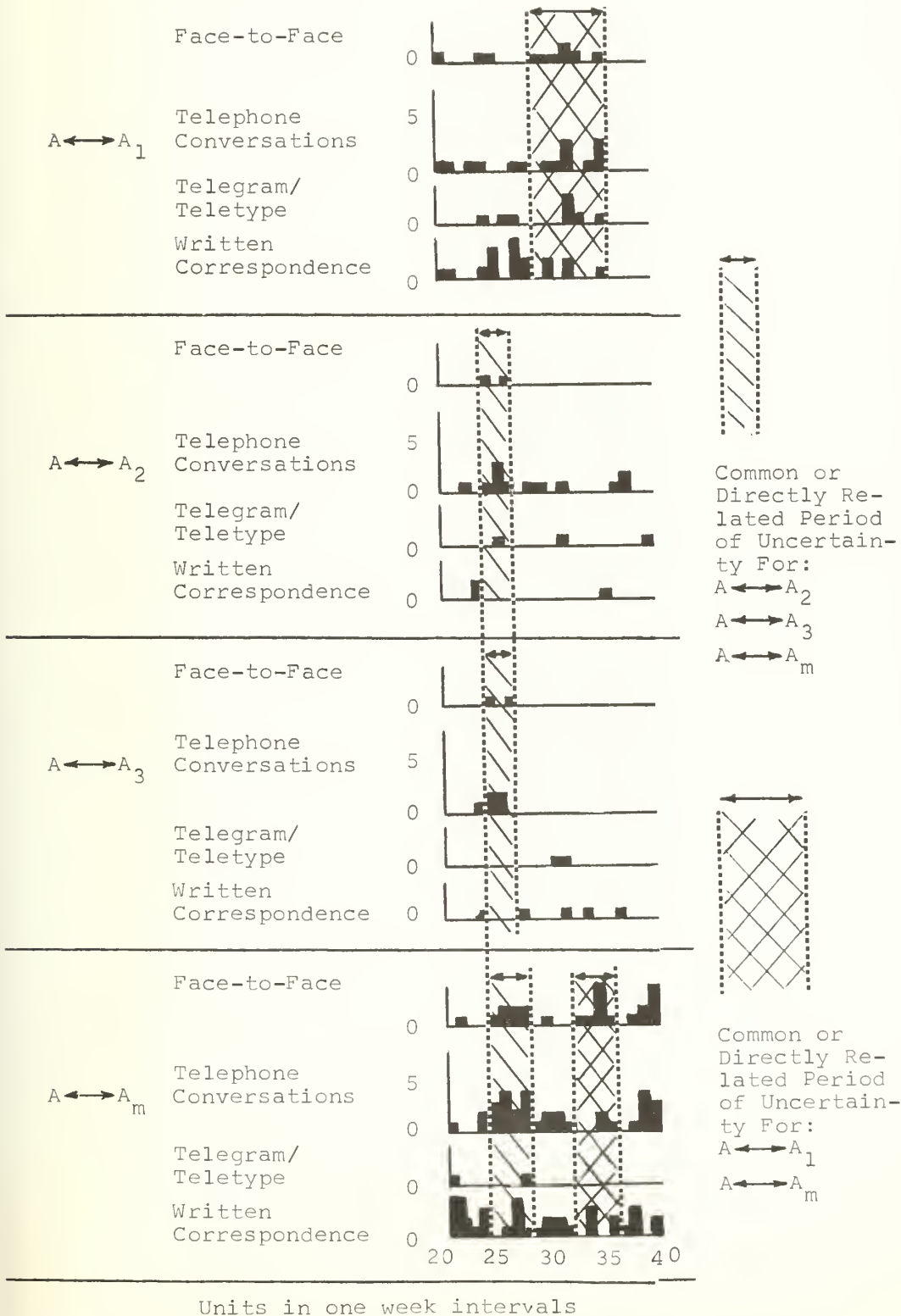
there was little or no utilization of the telephone conversation channel, while during the same respective time periods, there was a sharp and dramatic increase in the utilization of the face-to face channel. Figure 7-6 presents the transacting set $B \longleftrightarrow B_2$ and shows the reverse of the above utilization pattern of the face-to-face and telephone conversation channels. The second (7th through 10th weeks) and fourth (27th through 30th weeks) periods of uncertainty of this transacting set indicated that there was a greater frequency in the utilization of the telephone conversation channel when there was a decrease in the utilization of the face-to-face channel. In both of these periods, there was zero utilization of face-to-face interaction and there was a greater utilization in the telephone conversation channel as compared with the other periods of uncertainty of this set. It appeared, therefore, that there was an inherent trade-off function between these two channels. During periods of uncertainty, when the frequency of utilization of the face-to-face channel was low, there was an apparent increase in the frequency of utilization of the telephone conversation channel. And similarly, when the frequency of utilization of the telephone conversation channel was slight, there appeared to be a substantial increase in

the frequency of the utilization of the face-to-face channel during periods of uncertainty.

An interesting relationship between the different transacting sets of organizations of the same project is graphically presented in Figure 7-8. This Figure presents on one graph the four sets of transacting organizations of Project Alpha and shows the frequency of utilization of the interpersonal channels for the specific common time-frame of weeks twenty through forty. It was noted earlier in this chapter that $A \longleftrightarrow A_m$ had directly related periods of uncertainty with $A \longleftrightarrow A_1$, $A \longleftrightarrow A_2$, and $A \longleftrightarrow A_3$ that occurred during common timeframes. Figure 7-8 graphically presents these common periods of uncertainty. Table 7-1 revealed that the period of uncertainty of $A \longleftrightarrow A_m$ occurring during the weeks 25 through 28 was associated with the technical difficulties of $A \longleftrightarrow A_2$ and $A \longleftrightarrow A_3$ occurring during the period of uncertainty of weeks 25 through 27. It also revealed that the period of uncertainty of $A \longleftrightarrow A_m$ occurring during the weeks 33 through 36 was directly related to the period of uncertainty of $A \longleftrightarrow A_1$ occurring during the weeks 30 through 36. Figure 7-8 indicates that there was an overall increase in frequency of utilization of the interpersonal channels during the common periods of uncertainties for the relevant

FIGURE 7-8

FREQUENCY OF UTILIZATION DURING PERIODS OF UNCERTAINTY DIRECTLY
RELATED TO A PROBLEM COMMON TO THE TRANSACTING ORGANIZATIONS



sets of transacting organizations. During weeks 25 through 27 there was an increase in frequency of utilization of sets $A \longleftrightarrow A_2$, $A \longleftrightarrow A_3$ and, correspondingly, there was increase in utilization of $A \longleftrightarrow A_m$ during weeks 25 through 28. During weeks 30 through 36 there was an increase in frequency of utilization of the set $A \longleftrightarrow A_1$ and, correspondingly, there was an increase in utilization of $A \longleftrightarrow A_m$ during weeks 33 through 36. It appeared that during critical periods of uncertainty, not only was there an increase in the use of the interpersonal channels between the prime organization and sub organization, but there was a directly related increase in the use of the interpersonal channels between the prime organization and the monitoring organization.

The graphs of Figures 7-1 through 7-7 visually present the frequency of utilization of the interpersonal channels during the specified timeframes of Projects Alpha and Bravo. Tables 7-2 and 7-3 present the average weekly values of frequency of utilization of the channels of the various sets of transacting organization for periods of uncertainty and certainty. The data from which the frequencies of these figures and tables were computed were measured on an ordinal scale and, therefore, were not suitable for parametric testing methods. Additionally, the small size of the sample which often

occurred in the frequencies of the face-to-face and teletype/telegram channels limited the use of many of the non-parametric tests such as the Chi Square Test. Therefore, a Kolmogorov - Smirnov one sample test was utilized to determine if the observed increases and decreases in magnitude of the frequency of utilization of a channel during the project time period were likely on the basis of chance or not likely on the basis of chance. For this test, the given theoretical distribution of the frequencies of each channel was a uniform distribution. The results of this test are presented in Table 7-4. For telephone conversations, the observed increases in magnitude of frequency of utilization for five of the seven sets of transacting organizations were either statistically significant or approached significance, and were not likely on the basis of chance. For face-to-face and teletype channels, the observed increases in magnitude of frequency of utilization for two of the seven sets of transacting organizations were either statistically significant or approached significance. It appeared that the small number of observed frequencies recorded (often $n = 1, 2, \text{ or } 3$) for these two channels somewhat limited the use of this test and resulted in the level of significance of 0.10 or less being diffi-

KOLMOGOROV-SMIRNOV ONE SAMPLE TEST RESULTS OF INCREASES IN
MAGNITUDE OF FREQUENCY OF CHANNEL UTILIZATION

Sample	Transacting Organizations	Channel	Level of Significance	Sample	Transacting Organizations	Channel	Level of Significance
Project Alpha	A ↔ A ₁	F to F	.50	Project Bravo	B ↔ B ₁	F to F	.20
		TC	.10*			TC	.05**
		T	.50			T	.50
		WC	.25			WC	.30
	A ↔ A ₂	F to F	.10*		B ↔ B ₂	F to F	.30
		TC	.25			TC	.01**
		T	.05**			T	.07*
		WC	.17			WC	.50
	A ↔ A ₃	F to F	.001**		B ↔ B ₃	F to F	.30
		TC	.001**			TC	.05**
		T	.19			T	-
		WC	.07*			WC	.23
	A ↔ A _m	F to F	.25	* Approached Statistical Significance			
		TC	.17	** Statistically Significant			
		T	.25	F to F = Face to Face			
		WC	.50	TC = Telephone Conversation			
				T = Teletype/Telegram			
				WC = Written Correspondence			

cult to reach. For the written correspondence channel, none of the seven sets of transacting organizations were statistically significant and only one of the observed increases in magnitude of frequency of utilization approached statistical significance. This was consistent with the previous tables and figures which showed apparent relative non-importance of the written correspondence channel. It appeared, therefore, that the increases and decreases in magnitude of the frequency of utilization of the telephone conversation were significant, that the increases and decreases of the face-to-face and teletype channels were slightly on the significant side, and that the increases and decreases of the written correspondence channel were not significant. However, these results were generally modest and no consistent trend, with the exception of the telephone conversation channel was apparent.

The analysis of the changes in utilization of interpersonal channels as a function of periods of project uncertainties in the first context discussed in the introduction to this chapter is now complete. In this context, the differences in frequency of utilization of each individual channel during periods of uncertainty and certainty were examined; and the changes in frequency of

each interpersonal channel were compared with the designated periods of uncertainties. The second context can now be examined. In this context, channel utilization was examined by measuring the richness of communication concept of each interpersonal channel in relation to periods of uncertainty.

Tables 7-5 and 7-6 were constructed to aid in the examination of the second context. These tables show the percentage increase in utilization of each interpersonal channel of each transacting set of organizations during periods of uncertainty. The averages computed for Tables 7-2 and 7-3 were utilized to compute these percentages. In order to compare differences in frequency of utilization between the four interpersonal channels, each individual period of uncertainty and the combined period of uncertainty for each transacting set was again shown on these tables. The average amount of weekly utilization of a channel during a period of uncertainty and during a period of certainty was shown on Tables 7-2 and 7-3. Using these two averages, a percentage increase in channel utilization between periods of certainty and uncertainty was computed. In turn, the other three channels' percentage increases during the same period of

TABLE 7-5

PERCENTAGE INCREASE IN UTILIZATION OF INTERPERSONAL CHANNELS DURING PERIODS OF UNCERTAINTY

Sample	Transacting Organizations	Channel	% Increase During Individual Periods of Uncertainty					% Increase During Combined Period of Uncertainty	Rank of Channel According to Greatest % Increase
			1	2	3	4	5		
A ↔ A ₁	F to F	322	271					299	1
	TC	445	132					289	2
	T	165	31					98	3
	WC	20	Neg					Neg	4
A ↔ A ₂	F to F	857						857	1
	TC	364						364	2
	T	200						200	3
	WC	Neg						Neg	4
A ↔ A ₃	F to F	809	1118					936	1
	TC	733	1008					850	2
	T	Neg	Neg					Neg	3
	WC	Neg	Neg					Neg	4
A ↔ A _m	F to F	317	317	495	288	376		348	1
	TC	284	Neg	388	83	266		188	2
	T	39	39	178	111	11		78	3
	WC	Neg	Neg	22	29	Neg		5	4

F to F = Face to Face
 TC = Telephone Conversation
 T = Teletype/Telegram
 WC = Written Correspondence

TABLE 7-6
PERCENTAGE INCREASE IN UTILIZATION OF INTERPERSONAL
CHANNELS DURING PERIODS OF UNCERTAINTY

Sample	Transacting Organizations	Channel	% Increase During Individual Periods of Uncertainty				% Increase During Combined Period of Uncertainty	Rank of Channel According to Greatest % Increase
			1	2	3	4		
B \longleftrightarrow B ₁		F to F	∞				∞	1
		TC	420				420	2
		T	∞				∞	1
		WC	100				100	4
Project Bravo B \longleftrightarrow B ₂		F to F	∞	0	∞	0	∞	1
		TC	355	582	527	586	525	2
		T	Neg	496	Neg	Neg	48	4
		WC	51	279	203	0	167	3
B \longleftrightarrow B ₃		F to F	1048				1048	1
		TC	356				356	2
		T	-				-	-
		WC	333				333	4

F to F = Face to Face
TC = Telephone Conversation
T = Teletype/Telegram
WC = Written Correspondence

uncertainty were computed which facilitated the comparison of the percentage increases (or decreases) of all four channels against one another.

The most noteworthy feature of these tables was the apparent consistent richness pattern of channel usage during periods of uncertainty. It appeared that the face-to-face channel increased in utilization the greatest amount, followed in order by telephone conversations, teletype/telegram messages, and written correspondence. In thirteen of the sixteen individual periods of uncertainty, the face-to-face channel had the greatest percentage increase in utilization. In eleven of the sixteen individual periods of uncertainty, the telephone conversation channel had the second highest percentage increase in channel utilization. In nine of the sixteen individual periods of uncertainty, the telephone channel had the third highest percentage increase in channel utilization. In one set in which the teletype channel was tied for the highest percentage increase ($B \longleftrightarrow B_1$), the sample of this channel was only one ($n = 1$). And in another set ($B \longleftrightarrow B_2$) in which the teletype channel was last in percentage increase for three periods of uncertainty, the sample of this channel was only two ($n = 2$). In twelve of the sixteen individual periods of uncertainty,

the written correspondence channel was last in the percentage increase in channel utilization. The individual periods of uncertainty, then, appeared to indicate a consistent general trend in the utilization of the face-to-face channel the most, the telephone conversation next, the teletype channel third, and the written correspondence the least in utilization.

This pattern was more evident and pronounced in the combined periods of uncertainty. In seven out of seven combined periods of uncertainty, the face-to-face channel had the highest percentage increase in channel utilization. In six of the seven combined periods of uncertainty, the telephone conversation had the second highest percentage increase in channel utilization. In five out of seven combined periods of uncertainty, the teletype/telegram channel had the third highest percentage increase in channel utilization, and in six out of seven of the combined periods of uncertainty, the written correspondence channel was last in the percentage increase in channel utilization.

Considering the analysis of both contexts of changes in utilization of interpersonal communication channels, the general picture that emerged was one of increasing use of interpersonal channels during periods of

uncertainty. Of this increasing utilization, the face-to-face channel increased the greatest amount, with the telephone conversation channel second, the teletype/telegram channel third and the written correspondence channel utilization the least amount. The data more often than not suggested that average weekly frequency of channel utilization during periods of uncertainty was higher than during periods of certainty. The graphical presentations suggested a one-to-one correspondence or correlation between periods of uncertainty and increased frequency of utilization of the interpersonal communication channels. It also appeared that the most discernible and largest increases in frequency of utilization during periods of uncertainty occurred in the face-to-face and telephone conversation channels. This corresponded with the analysis of the percentage increases in channel utilization. It appeared that when a period of uncertainty occurred, the face-to-face channel was utilized the most, the telephone conversation channel utilized less than face-to-face but more than the teletype and written correspondence channels, the teletype channel utilized third in preference, and the written correspondence channel utilized the least of all the channels. There were some exceptions, but they were few and appeared to be modest differences.

In general, the above patterns of utilization appeared to be consistent throughout the data. This investigation will now proceed to examine Supporting Hypothesis One.

Test of Supporting Hypothesis One

Three supporting hypothesis were devised to test specific premises concerning changes in the utilization of interpersonal communication channels between the transacting organizations of a research and development project as a function of project uncertainties. The testing of the first of the three supporting hypotheses will be examined in the remainder of this section.

Supporting Hypothesis One is as follows:

SH-1 Interpersonal communication channel utilization between the transacting organizations is a function of the uncertainties arising from project problems such as: unforeseen or unexpected technical, budgetary, administrative, and contractual problems. It is expected that channel utilization will increase with the occurrence of any one of these types of problems and that there will be, concurrently, an increase in the use of the richer channels of communication.

There are two contexts of changes in utilization of the interpersonal channels with which this supporting hypothesis is concerned. One is the expected increase in channel utilization with the occurrence of any one of the unforeseen or unexpected project problems. The second is the expected increase in the use of the richer channels

of communication during a period of uncertainty. Both of these contexts were discussed in the analysis of the previous section, and it was found that there were ample data in the two sample projects for the examination and testing of these changes in utilization of the interpersonal channels.

This supporting hypothesis was considered confirmed if it could be shown that: (1) there was a one-to-one correlation between periods of uncertainty and increased frequency of utilization of the interpersonal channels, (2) the average weekly frequency of utilization of the individual channels of the transacting sets was greater during periods of uncertainty than during periods of certainty, and (3) the percentage increases in utilization of the individual channels during periods of uncertainty were progressively larger for the richer communication channels. A detailed analysis and discussion of these three criteria was performed in the last section. The data in Figures 7-1 through 7-7 relate to the first measure, the data in Tables 7-2 and 7-3 relate to the second measure, and the data in Tables 7-5 and 7-6 relate to the third measure.

A review of the data in Figures 7-1 through 7-7 indicated that for both individual and combined periods of uncertainty there was a one-to-one correspondence or

correlation between these periods and increased frequency of utilization of the interpersonal communication channels. A review of Tables 7-2 and 7-3 indicated that average weekly frequency of channel utilization during periods of uncertainty was higher than the average weekly frequency of channel utilization during periods of certainty. This was true for all the combined weekly averages of periods of uncertainty of Project Bravo, and for the majority of the combined weekly averages of periods of uncertainty of Project Alpha. This was also true for the overwhelming majority of the individual periods of uncertainty of the four individual channels of both projects. A review of Tables 7-5 and 7-6 indicated that there was a consistent richness pattern of channel utilization during periods of uncertainty. For both combined and individual periods of uncertainty it was readily apparent that the face-to-face channel had the highest percentage increase in channel utilization during periods of uncertainty, the telephone conversation channel was second, the teletype/telegram channel third, and the written correspondence channel had the lowest percentage increase.

Table 7-7 summarizes the results of the analysis and examination of the data in conjunction with the three testing criteria of Supporting Hypothesis One. Shown in

TABLE 7-7
SUMMARY OF ANALYSIS OF SUPPORTING HYPOTHESIS ONE

Sample	Transacting Organizations	Channel	Is there an apparent 1 to 1 correlation between periods of uncertainty increased utilization channels?
Project Alpha	$A \longleftrightarrow A_1$	F to F	Yes
		TC	Yes
		T	Yes
		WC	No
Project Alpha	$A \longleftrightarrow A_2$	F to F	Yes
		TC	Yes
		T	No
		WC	No
Project Alpha	$A \longleftrightarrow A_3$	F to F	Yes
		TC	Yes
		T	No
		WC	No
Project Alpha	$A \longleftrightarrow A_m$	F to F	Yes
		TC	Yes
		T	Yes
		WC	No
Project Bravo	$B \longleftrightarrow B_1$	F to F	Yes
		TC	Yes
		T	Yes
		WC	Yes
Project Bravo	$B \longleftrightarrow B_2$	F to F	Yes
		TC	Yes
		T	Yes
		WC	Yes
Project Bravo	$B \longleftrightarrow B_3$	F to F	Yes
		TC	Yes
		T	-
		WC	Yes

F to F = Face to Face

TC = Telephone Conversation

TABLE 7-7 (continued)

Is the average Weekly frequency of utilization during periods of uncertainty higher than during periods of certainty?	Rank of channel according to greatest % increase in utilization of channels during periods of uncertainty
Yes	1
Yes	2
Yes	3
No	4
Yes	1
Yes	2
No	3
No	4
Yes	1
Yes	2
No	3
No	4
Yes	1
Yes	2
Yes	3
Yes	4
Yes	1
Yes	2
Yes	1
Yes	4
Yes	1
Yes	2
Yes	4
Yes	3
Yes	1
Yes	2
-	-
Yes	4

T = Teletype/Telegram

WC = Written Correspondence

the table are:

1. Whether one-to-one correlation between periods of uncertainty and increased frequency of utilization of channels was apparent.
2. Whether average weekly frequency of utilization of channels was higher during periods of uncertainty and lower during periods of certainty.
3. The richness rank of the channels of each transacting set of organizations according to the greatest percentage increase in utilization of the channels during periods of uncertainty.

The data in Table 7-7 showed an apparent one-to-one correlation in twenty one of the twenty seven inter-organizational channels. Of the six inter-organizational channels that did not indicate a one-to-one correlation, the written correspondence channel accounted for four of the instances, and the teletype channel the remaining two. Both were the least rich of the four types of inter-personal communication channels. The table showed that the average weekly frequency of utilization of channels was higher during periods of uncertainty in twenty three

of the twenty seven instances; and of the four lower averages, three occurred in the written correspondence channel, and one occurred in the teletype/telegram channel. The table also showed that the face-to-face and telephone conversation channels ranked 1, 2 in richness utilization in all seven of the transacting sets of organizations. Additionally, in five of the seven sets face-to-face, telephone conversation, teletype, and written correspondence ranked 1, 2, 3, 4 in the greatest percentage increase in utilization of channels during periods of uncertainty.

The overwhelming weight of evidence, therefore, supported the first supporting hypothesis that interpersonal channel utilization is a function of the uncertainties arising from unforeseen or unexpected project problems. Supporting Hypothesis One is considered confirmed.

Summary and Discussion

Reviewing all the data presented in this chapter and the results of the analysis and testing of the first supporting hypothesis, it was possible to conclude that interpersonal communication channel utilization between transacting organizations does occur as a function of project problem uncertainties in the two projects examined.

In a few of the individual channels within certain sets of transacting organizations, these channel utilization patterns could not be confirmed. Nevertheless, the general picture that emerged was one of increasing utilization of interpersonal communication channels during periods of uncertainty.

Additionally, in the few cases where it was not confirmed that channel utilization is a function of uncertain periods; the majority of the individual channels in these cases were the written correspondence channels, and the remaining channels were the teletype channels. The latter is a strong feature of the data that emerges markedly and regularly throughout this analysis and examination. The increased utilization and evident reliance on the face-to-face and telephone channels during periods of uncertainty emerged consistently and very discernibly as was shown in the tables and figures of this chapter. Table 7-7 showed that in each transacting set of organizations the face-to-face and the telephone conversation channels were the only channels which:

- (1) had one-to-one correspondence between periods of uncertainty and increased frequency of utilization, (2)
- had the average weekly frequency of utilization higher during periods of uncertainty than during periods of

certainty, and (3) ranked 1, 2 according to the greatest percentage increase during periods of uncertainty. This consistent pattern of utilization of the face-to-face and telephone conversation channels directly corresponded with the concept of richness of communication developed in Chapter Three.

The analysis of the graphical presentations illuminated several interesting and possible channel utilization characteristics. In general, it appeared that there were definite gradations in the rate of increase and decrease of utilization of the face-to-face and telephone conversation channels. It was apparent that there was a gradual crescendo rise in the utilization of these two channels as a period of uncertainty germinated and was recognized, it continued the constant increase until it reached a high point, and then dropped off rapidly and sharply as the period of uncertainty concluded. Another interesting characteristic was the apparent built in or inherent trade-off function between the face-to-face and telephone conversation channels during periods of uncertainty. It appeared that there was some necessary amount of total channel utilization between the transacting organizations during these periods. When the frequency of utilization of the face-to-face channel was

low, there was an apparent increase in the frequency of utilization of the telephone conversation channel during these critical periods. And, similarly, when the frequency of utilization of the telephone conversation channel was relatively light, there appeared to be a substantial increase in the frequency of utilization of the face-to-face channel during periods of uncertainty.

Another interesting feature was the inter-relationship of communication patterns between prime organizations, sub organizations, and a monitoring or directly related organization. It appeared that when a critical period of uncertainty arises, there was an increase in the general utilization of the interpersonal channels and a marked and greater increase in the utilization of the face-to-face and telephone conversation channels, respectively. These increases occurred not only between the prime organization and the relevant sub organization experiencing the critical period of uncertainty, but also occurred simultaneously between the prime organization and the monitoring or sponsoring organization. The patterns of communication utilization traced a similar path through several related transacting organizations during a critical period of uncertainty.

There were several interesting differences in

the communication utilization patterns between the two projects. There was a greater amount of channel utilization over the total project timeframe with the transacting organizations of Project Alpha than there was with the transacting organizations of Project Bravo. This was expected as the dollar size of Project Alpha was four times the size of Project Bravo. What was interesting, however, was the frequency of utilization of the face-to-face and telephone conversation channels of Project Bravo as compared with Project Alpha. In each transacting set of Project Bravo, the increases in utilization of these two channels was much more discernible and in evidence than in the transacting sets of Project Alpha. In fact, all of the combined weekly averages of frequency of utilization for periods of uncertainty of each type of channel and for each set of transacting organizations of Project Bravo were higher than the averages for periods of certainty. While in Project Alpha, the same pattern was only true for one of the four transacting sets of organizations. Perhaps the most distinctive feature was the comparison of the percentage increases of the face-to-face channels between the two projects during periods of uncertainty. The percentage increases in utilization of the face-to-face channel were higher in every set of transacting organizations of Project

Bravo in comparison with the face-to-face percentage increases for the transacting organizations of Project Alpha.

It will be recalled that the prime organization of Project Bravo was located in a relatively small metropolitan city which was neither a communication nor transportation center and was not a stop on the important or major air transportation routes. Project Alpha, on the other hand, was a large contract and the prime organization was located in a large industrial metropolitan area which was one of the nation's major transportation and communication centers. The weight of the evidence presented in this chapter supported and confirmed that the utilization of interpersonal communication channels was a function of project problem uncertainties, in the case of Project Alpha. However, the analysis and examination of the data of Project Bravo confirmed, a fortiori, that though factors existed that act to limit face-to-face communication, such as the relative small dollar size of the contract and the location of the prime organization in a small city not on a major transportation route, the utilization of interpersonal channels is still a function of project problem uncertainties. In spite of the inherent air transportation restrictions, the transacting sets of

Project Bravo utilized the face-to-face channel to a comparative greater extent than the transacting organizations of Project Alpha.

CHAPTER EIGHT

INTERPERSONAL COMMUNICATION CHANNEL UTILIZATION AS A FUNCTION OF OTHER RELEVANT PROJECT UNCERTAINTIES

Introduction

Is there a relationship between other types of project uncertainties or factors and the utilization of interpersonal communication channels between the transacting organizations of a research and development project? This general question was examined by answering two more specific questions: (1) Does the determinability and complexity of products or services between the transacting project organizations relate to the utilization of the interpersonal communication channels? (2) Is Interpersonal channel utilization between project organizations related to the nature and characteristics of inter-organizational relationships?

Changes in channel utilization as a function of these types of uncertainties or factors were examined in terms of three measures. For the first, utilization was examined by computing the combined weekly average of frequency of utilization of the four channels of each set of transacting organizations during periods of problem uncertainties and comparing these averages among the

transacting organizations of each project. This measurement was similar to that discussed and utilized in the previous chapter. The second measure was also similar to the second measure discussed in Chapter Seven. In this measure, channel utilization was examined by measuring the richness of communication aspect of each interpersonal channel. The percentage changes in frequency of each of the four channels during the combined periods of uncertainty were compared with one another and the other transacting organizations to examine the differences in the relative utilization of the interpersonal communication channels between transacting sets of organizations. For the third measure, the volume of channel utilization was examined. In this situation, the total number of utilization instances of each of the four interpersonal channels for each transacting set during the timespan of the project was measured, and the values of each transacting organization set were compared with one another.

In the following sections of this chapter, after a brief discussion of the measurement of determinability of products or services and the measurement of a limited number of inter-organizational relationships, the data are presented and discussed in terms of these measurements and the utilization of the interpersonal channels. Supporting Hypotheses Two and Three are then discussed

in terms of the extent to which the data support them.

The chapter closes with a summary and discussion of the relevant findings and additional possible relevant factors and uncertainties related to channel utilization.

The Measurement of Determinability and Inter-Organizational Relationships

Two variables were examined and measured in this chapter. The first of these was the determinability and complexity of products or services furnished by the sub organizations to the prime organization of each project. This uncertainty or factor is concerned with the determinate degree or character of the product or service. Is it a product that has exact limits, is definite or fixed, a routine or catalogue type of item; or is it undeterminable, non-routine, a one-of-a-kind, never before developed type of product or service?

To evaluate the variation in this uncertainty, the project manager and relevant project personnel were asked the following question during an interview concerning the product or service rendered by a sub organization:

1. A dichotimization might be made concerning the determinability and complexity of products or services rendered to you by the sub organization. How would you describe this variable along the following spectrum?

Determinable
Routine
Catalogue Item

Undeterminable
Non-routine
One-of-a-kind

1 2 3 4 5 6 7

This was not an exact measurement, as the scale incorporated in the question was an ordinal scale. This was not a truly quantitative scale but incorporated only the relation of equivalence and "greater than" or "higher than". Therefore, the measurements obtained from this variable were not exact indicies or numerical values but were orderings or rankings of sub organizations and as such limit the transformation of the information obtained up to a monotonic transformation.

The second variable examined and measured was the inter-organizational relationships between the prime organization and the sub organizations of a project. Two types of relationships were investigated. One was the degree of prior relationships between transacting organizations. Was this the first business transaction between the two organizations or had there been numerous prior dealings or contracts between the organizations? To evaluate this type of inter-organizational relationship the prime organization was interviewed concerning relationships with sub organizations and asked the following question:

1. To what extent have you had prior business transactions or contracts with the sub organization?

Numerous prior transaction, a well established prior relationship

First business transaction, no prior relationship

1 2 3 4 5 6 7

The second type of inter-organizational relationship related to the degree and characteristics of business dependability and reliability established between the prime organization and sub organizations. Did the sub organization meet its promises and conduct its transactions in a reliable and above-board manner? To evaluate this relationship, the prime organization was asked the following question:

2. A rough dichotimization might be made concerning the business practices and reliability of the sub organization. How would you describe this variable along the following spectrum?

Excellent reliability and high confidence in business practices

Poor business practices, not dependable, unreliable

1 2 3 4 5 6 7

As with the first uncertainty or factor of determinability, the measurement scale of the two types of inter-organizational relationships was not a truly quantitative scale but an ordinal scale of preferences or ordering.

Analysis of Data

The measurement results showing the ordering and preference rankings among the sub-organizations of each project for the two types of uncertainties or factors relevant to interpersonal channel utilization are shown in Table 8-1.

Several interesting patterns or features are exhibited by the data in this table. There was a general consistent ordering or preference ranking between the transacting sub organizations for each type of uncertainty. Sub organization A_1 had the highest ranking among the sub organizations of Project Alpha for each type of uncertainty or factor. It was followed in order by A_2 and then A_3 , thereby resulting in the ranking order from high to low of A_1 , A_2 , A_3 for each type of uncertainty. The sub organizations of Project Bravo did not follow as consistent a pattern as those of Project Alpha. This was due to the measurements of equivalence for the second type of uncertainty. In the measurement of the extent of

TABLE 8-1

MEASUREMENT OF THE VARIATION OF UNCERTAINTIES OF DETERMINABILITY AND
INTER-ORGANIZATIONAL RELATIONSHIPS BETWEEN TRANSACTING ORGANIZATIONS

Type of Uncertainty	Project	1	2	3	4	5	6	7
Determinability and Complexity of Product or Service		Determinable Routine			Non-Routine One-of-a-kind			
	ALPHA				A ₃	A ₂		A ₁
	Bravo					B ₁ B ₃		B ₂
Extent of Previous Business Transactions		Numerous prior transactions, a well established prior relationship			First business transaction, no previous relationship			
	ALPHA		A ₃				A ₂	A ₁
	BRAVO							B ₁ B ₂ B ₃
Reliability and Dependability in Business Practices		Excellent business reliability and dependability			Poor business practices, unreliable			
	ALPHA				A ₃	A ₂		A ₁
	BRAVO		B ₁			B ₃		B ₂

previous business transactions, sub organizations B_1 , B_2 , and B_3 were given equivalent rankings, as all of them have no previous business dealings or transactions with prime organization B. In each type of uncertainty or factor, sub organization B_2 was either the highest ranking or tied for the highest ranking, and a mild pattern of ordering of B_2 , B_3 , and B_1 was exhibited.

Changes in channel utilization as a function of these types of uncertainties or factors were analyzed in terms of three different measures. The data were basically the same as those utilized in Chapter Seven except for the addition of the volume of utilization. The timeframe or span of the project's life examined was modified in the case of Project Alpha, however. Because the contract with A_1 was terminated at the end of the thirty-sixth week, the timeframe examined for $A \longleftrightarrow A_1$ was still the first Thirty-six weeks. The eighty week timeframe for $A \longleftrightarrow A_2$ and $A \longleftrightarrow A_3$ was modified to this first thirty-six week timespan in order to allow the comparison of volume of instances of communication, as well as the other contexts of channel utilization, between the sub organizations A_1 , A_2 , and A_3 of Project Alpha. The project timespan examined for Project Alpha was, therefore, the first thirty-six weeks for which the data was collected. The forty

week timespan of Project Bravo, which was examined in Chapter Seven, remained the same.

In the first measure of changes in channel utilization, the average frequency of channel utilization for each set of transacting organizations during their respective combined periods of uncertainty and during their period of certainty were computed. These data are included in Tables 8-2 and 8-3. The column " \bar{X}_{uc} " shows the combined average frequency per week of each of the four interpersonal channels for each transacting organization set during periods of uncertainty. The column " \bar{X}_{uc} " shows the total of the combined average weekly frequencies of the four channels for each respective set of transacting organizations.

The most distinctive feature of these data were the differences in interpersonal channel utilization between the transacting sets of each project. The comparison of the face-to-face channel within Project Alpha indicated that $A \leftrightarrow A_1$ had the highest combined average weekly frequency of this channel during periods of uncertainty, followed by $A \leftrightarrow A_2$ and $A \leftrightarrow A_3$. Each channel was compared in the same manner among the three transacting sets. The other three channels followed the same patterns as the face-to-face channel, and the data indicated that $A \leftrightarrow A_1$ had the highest combined weekly average,

TABLE 8-2
ANALYSIS OF THREE CONTEXTS OF CHANNEL UTILIZATION

Sample	Transacting Organizations	Channels	\bar{X}_{uc}	Total \bar{X}_{uc}	\bar{X}_c	% Increase	Volume	Total Volume
Project Alpha	$A \leftrightarrow A_1$	F to F	1.07		.27	299	21	
		TC	2.14		.55	289	42	
		T	1.07	5.21	.54	98	27	124
		WC	.93		.95	Neg	34	
	$A \leftrightarrow A_2$	F to F	.67		.12	458	6	
		TC	1.67	2.67	.37	351	17	
		T	.33		.18	83	7	
		WC	0		.24	Neg	8	38
	$A \leftrightarrow A_3$	F to F	.57		.15	280	8	
		TC	1.14	1.71	.31	268	17	
		T	0		.10	Neg	3	36
		WC	0		.28	Neg	8	

F to F = Face to Face
TC = Telephone Conversation
T = Teletype/Telegram
WC = Written Correspondence

TABLE 8-3

ANALYSIS OF THREE CONTEXTS OF CHANNEL UTILIZATION

Sample	Transacting Organizations	Channels	\sum Xuc	\sum Xuc	Total	\sum Xc	% Increase	Volume	Total Volume
B \longleftrightarrow B ₁	F to F	TC	.50		4.00	0	∞	2	
		T	2.75			.53	420	30	
		WC	.25			0	∞	1	44
			.50			.25	100	11	
Project Bravo	B \longleftrightarrow B ₂	F to F	.13		5.20	0	∞	2	
		TC	4.13			.66	526	82	
		T	.06			.04	48	2	108
		WC	.88			.33	167	22	
B \longleftrightarrow B ₃	F to F	TC	.33			.029	1048	3	
		T	2.83		4.33	.62	356	38	
		WC	1.17			—	—	—	57
						.27	333	16	

F to F = Face to Face
 TC = Telephone Conversation
 T = Teletype/Telegram
 WC = Written Correspondence

followed by $A \longleftrightarrow A_2$ and $A \longleftrightarrow A_3$, respectively. The total value of the combined weekly averages for each transacting set of Project Alpha also was consistent with the individual channel comparisons. These values indicated, again, that $A \longleftrightarrow A_1$ had the highest average of frequency of utilization of all four channels combined during periods of uncertainty, followed by $A \longleftrightarrow A_2$ and $A \longleftrightarrow A_3$.

These same data are presented in a different format in Table 8-4. This table presents the relative ranking of each transacting set of organizations by project according to the combined average weekly frequency of each interpersonal channel and the total of all four channels of each transacting set. This table indicates that the ranking of the transacting sets of Project Alpha, according to the utilization of the face-to-face, telephone conversation, and teletype channels, was $A \longleftrightarrow A_1$, $A \longleftrightarrow A_2$, and $A \longleftrightarrow A_3$ in the respective ranking order of 1, 2, 3. Because the written channel had a zero weekly average value for $A \longleftrightarrow A_2$ and $A \longleftrightarrow A_3$, the ranking of this channel was $A \longleftrightarrow A_1$ ranked one, and $A \longleftrightarrow A_2$ and A_3 tied for second order. The total average values also indicated that A_1 , A_2 , and A_3 ranked 1, 2, and 3, respectively, according to the total frequency of utilization of all four channels during periods of uncertainty.

TABLE 8-4

RANKING OF TRANSACTING ORGANIZATIONS ACCORDING TO THE
THREE CONTEXTS OF CHANNEL UTILIZATION

Sample	Transacting Organizations	Rank of Channels According to Xuc = Xuc and Total Xuc					Rank of Channels According to % Increases					Rank of Channels According to Volume and Total Volume				
		F to F	TC	T	WC	Total	F to F	TC	T	WC	F to F	TC	T	WC	Total	
Project Alpha	A ↔ A ₁	1	1	1	1	1	2	2	1	-	1	1	1	1	1	
	A ↔ A ₂	2	2	2	2	2	1	1	2	-	3	2	2	2	2	
	A ↔ A ₃	3	3	3	2	3	3	3	3	-	2	2	3	2	3	
Project Bravo	B ↔ B ₁	1	3	1	3	3	1	2	1	3	2	3	2	3	3	
	B ↔ B ₂	3	1	2	2	1	1	1	2	2	2	1	1	1	1	
	B ↔ B ₃	2	2	3	1	2	2	3	3	1	1	2	3	2	2	

F to F = Face to Face
TC = Telephone Conversation

T = Teletype/Telegram
WC = Written Correspondence

The data of combined weekly averages of frequency of utilization of Project Bravo did not indicate the consistent ranking or ordering trends between sub organizations as the data of Project Alpha did. Tables 8-2, 8-3, and 8-4 indicate that each of the four interpersonal channels had a different ranking order in its utilization between the sub organizations B_1 , B_2 , and B_3 . The ranking order of the total combined weekly averages, however, was the same as that of the telephone conversation channel. For these two columns the ranking of the transacting organizations appeared to be $B \longleftrightarrow B_2$ first, $B \longleftrightarrow B_3$ second, and $B \longleftrightarrow B_1$ third.

The second measure of changes in interpersonal channel utilization consisted of comparing the percentage increases in utilization of each interpersonal channel between the transacting organization of each project. Tables 8-2, 8-3, and 8-4 present this data under the columns "percentage increase". Examination of these tables shows that there were mild ranking or ordering patterns among the transacting organizations of Project Alpha and Project Bravo. It appeared that in Project Alpha, $A \longleftrightarrow A_2$ was generally ranked number one in the highest percentage increase in utilization of interpersonal channels between the sub organizations. In both the face-to-face and

telephone conversation channels, A_2 ranked first, A_1 ranked second, and A_3 ranked third. In the teletype channel the position of A_1 and A_2 were reversed, and in the written correspondence channel, there was no ordering or ranking available from the data. It appeared, therefore, that the general ranking order of sub organizations of Project Alpha for this context was A_2 first, A_1 second, and A_3 third.

The comparison of percentage increases in utilization of channels between the sub organizations of Project Bravo also indicated an apparent mild pattern of ordering or ranking. The greatest percentage increases occurred in the face-to-face and telephone conversation channels, and the ranking of the transacting organizations according to these figures was B_2 first, B_1 second, and B_3 third. This was not a strong consistent pattern for all four interpersonal channels, but it was apparent in the richest of the four channels, the face-to-face and telephone conversation channels.

In the last of the three measures of changes in channel utilization between the transacting organizations of the projects, the volume of channel utilization was examined. Again Tables 8-2, 8-3, and 8-4 present the data to be analyzed in this context under the columns

"volume" and "total volume". In this context the total number of instances of channel utilization for each of the four channels for each transacting set of organizations was recorded. In addition, the total number of instances of communication for the four channels combined for each transacting organization was recorded and the comparison of these volume values between the sub organizations of a project was made.

It appears that there was a consistent ordering or ranking pattern in relation to the volume of the individual channels for the sub organizations of Project Alpha. In all four interpersonal channels, $A \longleftrightarrow A_1$ ranked first, and in three of the four interpersonal channels, $A \longleftrightarrow A_2$ ranked second. It was apparent, therefore, that the ranking according to the volume of utilization of each individual channel was A_1 first, A_2 second, and A_3 third. This same ordering pattern held true for the total volume of all four interpersonal channels of each sub organization combined. The ranking or ordering according to these values was also A_1 first, A_2 second, and A_3 third.

There was also a general ordering pattern of the transacting organizations of Project Bravo according to the individual interpersonal channel volume values. In three of the four individual channels, the transacting

set $B \longleftrightarrow B_2$ ranked first. In three of the four individual channels, the transacting set $B \longleftrightarrow B_3$ ranked either second or first. It appeared, therefore, that the ordering or ranking according to the volume of instances of utilization of each of the four interpersonal channels was B_2 first, B_3 second, and B_1 third. Analysis of the total volume of all four interpersonal channels of each sub organization combined bore out this same general and consistent pattern of ordering. The volume values indicated that among the sub organizations of Project Bravo, B_2 ranked first, B_3 second, and B_1 third.

Considering the analysis of the three measures of changes of utilization patterns between the transacting sets of organizations of each project, the general picture that emerged was one of consistent patterns of ordering or ranking among the sub organizations of each project according to the values of the three measures presented. Table 8-4 indicated that the general ordering of the sub organizations of Project Alpha was A_1 first, A_2 second, and A_3 third. This ordering was apparent in relation to both the values of average frequency of utilization and the volume of instances of utilization. The first and second ranking positions were reversed for A_1 and A_2 according to the percentage increase values. The data for

Project Bravo also indicated a general ordering or ranking pattern among the sub organizations. In relation to the total combined values of both the average weekly frequency of utilization and the volume of utilization the ordering was B_2 first, B_3 second, and B_1 third. In relation to the percentage increase, B_2 still ranked first with B_1 second and B_3 third.

Therefore, the general ranking or ordering of project sub organizations for Project Alpha was A_1 first, A_2 second and A_3 third and for Project Bravo was B_2 first, B_3 second, and B_1 third. This investigation will now proceed to examine Supporting Hypotheses Two and Three.

Test of Supporting Hypotheses Two and Three

Supporting Hypotheses Two and Three were similar in nature in that they both were concerned with factors or similar types of uncertainties that affect the relative amount of utilization between different sub organizations of a research and development project. They were concerned with factors or uncertainties that result in channel utilization between the prime organization and a specific sub organization being higher or lower than the channel utilization between the prime organization and a different sub organization. This was a completely different

facet of channel utilization and a different category of uncertainty than those which were examined and tested in the investigation of Supporting Hypothesis One. In the first supporting hypothesis, channel utilization was examined in relation to the category of uncertainties arising from unforeseen or unexpected project problems between a prime organization and a sub organization only. This first hypothesis was concerned with the differences in utilization within one set of transacting organizations caused by relevant project problem uncertainties. It was not concerned with comparing one set of transacting organizations with another set of transacting organizations to determine factors or uncertainties which affect all transacting sets and account for relative differences in channel utilization between sets of organizations. It is with these factors or similar types of uncertainties that the second and third supporting hypotheses dealt.

The second and third supporting hypotheses are as follows:

- SH-2 Interpersonal communication channel utilization between the transacting organizations is a function of the variation in determinability and complexity of products or services. It is expected that for a non-routine, one-of-a-kind, undeterminable product or service, the volume, frequency, and richness of communication channels will be higher than for a routine, catalogue, or highly determinable product or service.

SH-3 Interpersonal communication channel utilization between the transacting organizations is a function of the nature and length of the inter-organizational relationships between the project personnel of the prime organization and the various sub organizations. It is expected that a prior established relationship or one of excellent business reliability and dependability will result in lower volume, frequency, and richness of communication channels than for a new relationship or one of poor business practices or reliability.

The analysis of the data in Tables 8-1, 8-2, 8-3, and 8-4 shows several interesting relationships between the variables. Table 8-1 indicates that the general ordering or ranking of sub organizations within a project was the same for both the factors or uncertainties of determinability of product and inter-organizational relationships. A sub organization, such as A_1 , which ranked highest in the variable of determinability of product also ranked highest in the inter-organizational relationship variables, A_2 ranked second, and A_3 third. A similar ordering pattern between the two variables was also apparent for the sub organizations of Project Bravo. Tables 8-2, 8-3, and 8-4 have indicated that there was a consistent pattern of ranking of sub organizations among the three measures of utilization examined, and that these same three measures of utilization were used in the examination and analysis of both of the uncertainties or

variables of Supporting Hypotheses Two and Three.

A closer examination of the two independent variables, factors, or uncertainties of these two supporting hypotheses indicated that they were not completely independent; and that these two variables of determinability of product and inter-organizational relationships were probably only two of a possible number of factors or variables which affected the degree of channel utilization patterns between different sets of transacting organizations of a common project. The degree of channel utilization patterns were the measurements and rankings of the three contexts analyzed in this chapter.

An examination of the analysis of Projects Alpha and Bravo indicated that there was a one-to-one correlation between the rankings of the sub organizations for the factor of determinability and the context of channel utilization of total volume. There was also an apparent one-to-one correlation between total volume and the rankings of the factor of business dependability and reliability relationships. A simple computation of a Kendall partial rank correlation between total volume and determinability of product, partialling out the effect of business relationships revealed that the partial rank correlation was zero. This resulted in the analysis not being able to conclude that the relation between total

volume and product determinability was independent or relatively independent of the influence of business relationships.

Therefore, it could not be assumed that the variables or factors of determinability of product and inter-organizational relationships were uncorrelated or were independently acting on the degree of channel utilization between different sets of transacting organizations of a common project. Because this study was a field or natural study and not an experimental study, it was not possible to attribute the differences or presence of volume of utilization to only one of the factors or uncertainties since the other factor or uncertainty was not controlled or held constant but was allowed to vary. Additionally, because the factors or variables of determinability of product and inter-organizational relationships were only two of a number of possible factors which influenced the degree of channel utilization, it was not possible to determine how much of the variance in channel utilization between differing sets of transacting organizations these two factors or variables alone accounted for.

In the original design of this study it was planned to examine and test Supporting Hypotheses Two and Three

separately. The analysis of the data presented in this chapter, however, indicated that it could not be assumed that the two types of uncertainties or factors of these supporting hypotheses were uncorrelated or acted independently on the degree of channel utilization between the differing sets of transacting organizations. Furthermore, as was discussed above, the two factors or uncertainties taken together could not be proved to be the causal factors in the varying utilization of interpersonal channels because it was not possible, in the scope of this study, to determine how much of the variance in channel utilization between differing sets of transacting organizations these two factors or uncertainties alone accounted for. Therefore, it was not possible to test these hypotheses separately or together as they could not be methodologically or statistically confirmed. It was possible, however, to examine the variables of these two supporting hypotheses to see if they exhibited any strong or weak tendencies to influence or affect the degree of channel utilization between the different sets of transacting organizations, and if they tended to be supportive or non-supportive of the predicted relationships.

Supporting Hypothesis Two was concerned with the

factor or uncertainty of determinability of product or service. It was predicted that for a non-routine, one-of-a-kind, undeterminable product, the volume, frequency, and richness of communication channels would be higher than for a routine, catalogue, or highly determinable product. Table 8-1 indicated that the ranking or ordering of sub organizations from undeterminable to determinable products or services was A_1 , A_2 , A_3 for Project Alpha and B_2 , B_3 , B_1 for Project Bravo. Figures 8-1 and 8-2 graphically present the frequency and volume of utilization during the specific timeframes of Project Alpha and Bravo. Figure 8-1 presents the three relevant sets of transacting organizations of Project Alpha and Figure 8-2 presents the three sets of transacting organizations of Project Bravo. It is readily apparent from these figures that the rank of the sub organizations according to the highest volume of channel utilization and frequency of utilization during project problem uncertain periods was A_1 first, and A_2 slightly higher than A_3 for Project Alpha and B_2 first, with B_3 very slightly higher than B_1 for Project Bravo.

Table 8-5 summarizes the results of the analysis of data of the three measures of channel utilization in Tables 8-2, 8-3, and 8-4. This table indicates if the

FIGURE 8-1

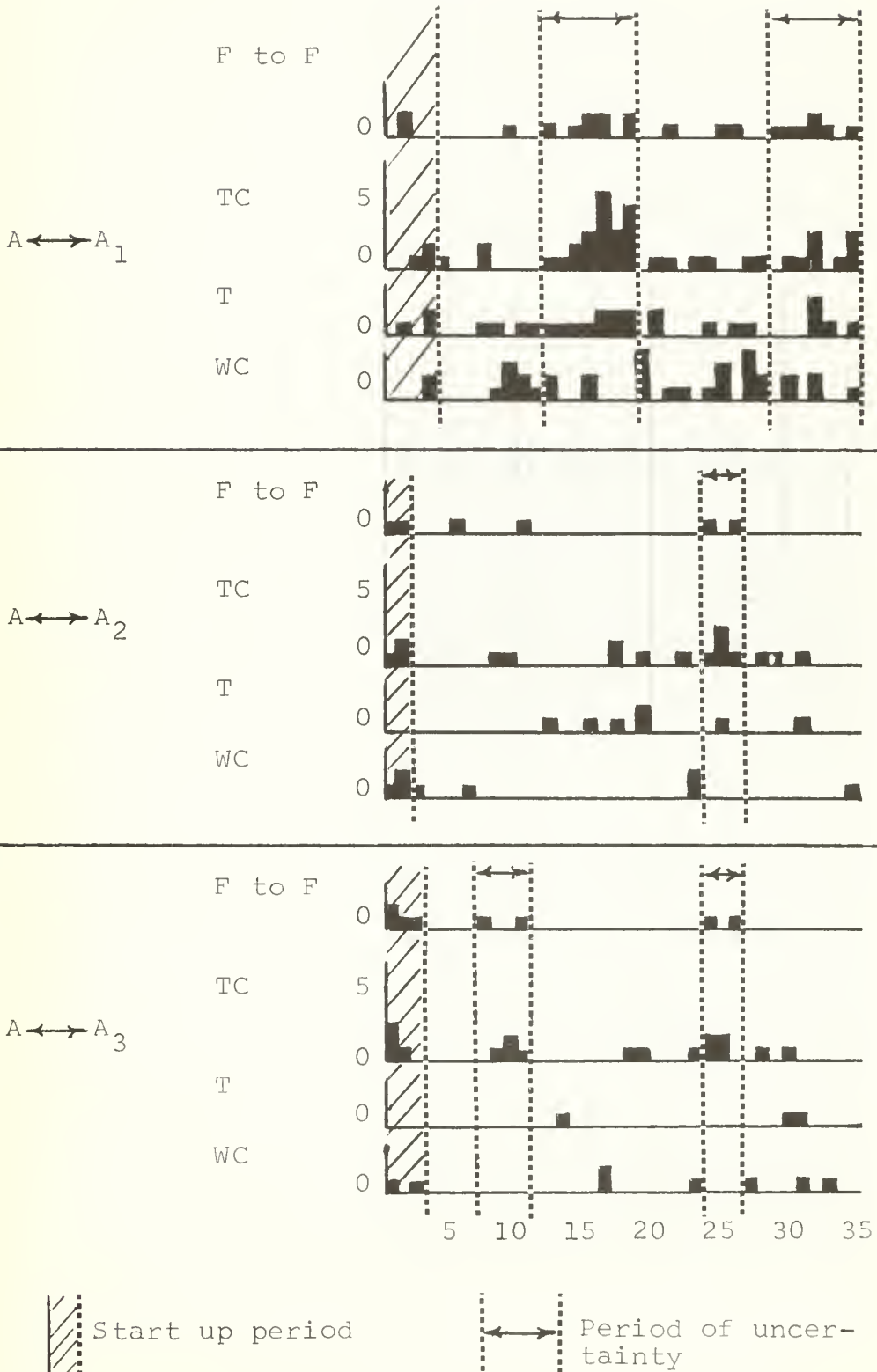
FREQUENCY OF UTILIZATION OF TRANSACTIONING ORGANIZATIONS
OF PROJECT ALPHA

FIGURE 8-2
FREQUENCY OF UTILIZATION OF TRANSACTING ORGANIZATIONS
OF PROJECT BRAVO

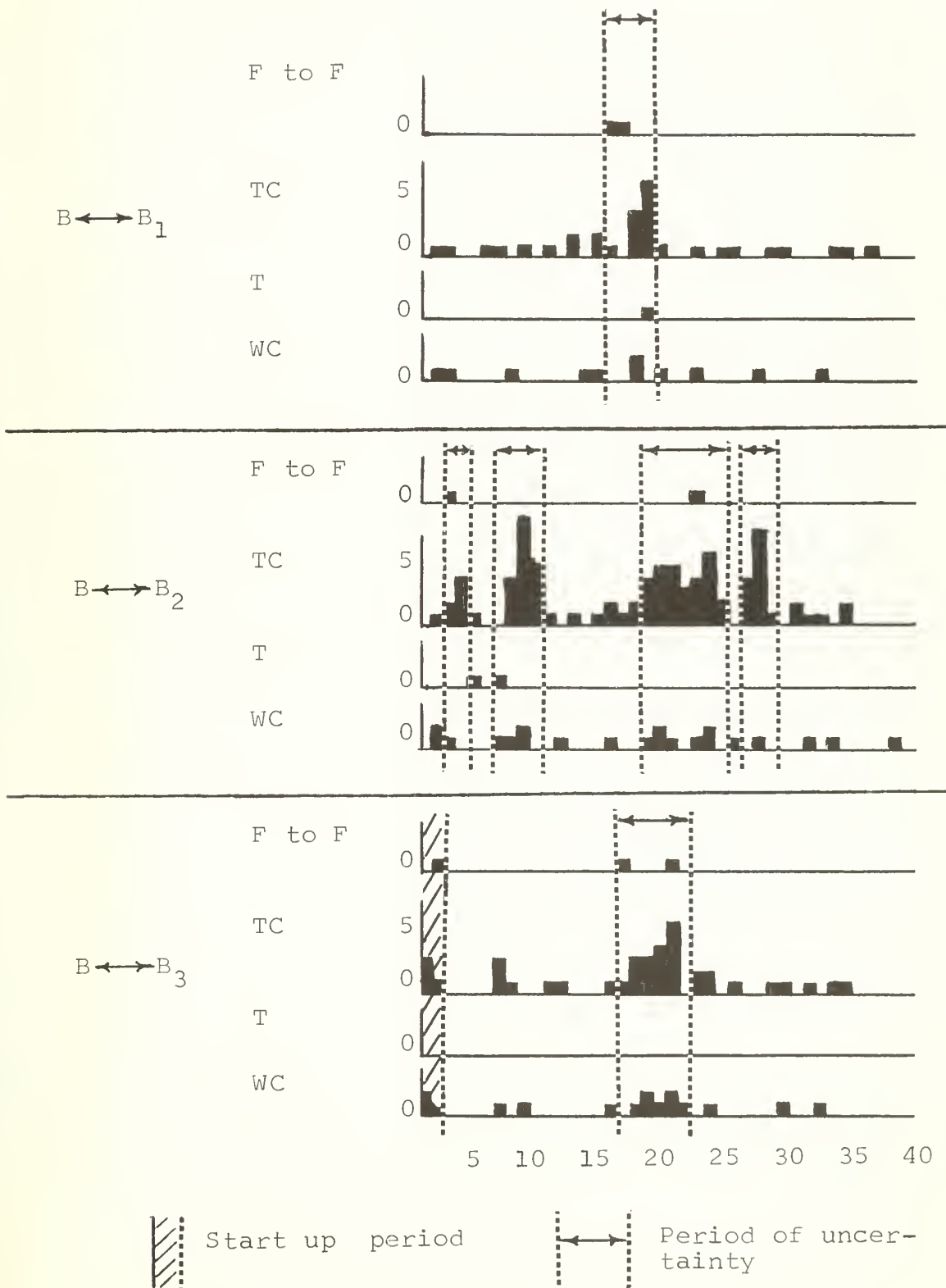


TABLE 8-5
SUMMARY OF RESULTS OF ANALYSIS OF THREE MEASURES
OF UTILIZATION INDICATING SUPPORT OR NON-SUPPORT
OF PREDICTED RELATIONSHIPS

Sample	Contest of Channel Utilization	Channel	Do Results of Analysis Show Supportive or Non-Supportive Tendencies?
Project Alpha	Combined Weekly Averages of Utilization	F to F	Supportive
		TC	Supportive
		T	Supportive
		WC	Supportive
		Total	SUPPORTIVE
	% Increases	F to F	Non-Supportive
		TC	Non-Supportive
		T	Supportive
		WC	----
	Volume	F to F	Slightly Supportive
		TC	Supportive
		T	Supportive
		WC	Supportive
		Total	SUPPORTIVE
Project Bravo	Combined Weekly Averages of Utilization	F to F	Non-Supportive
		TC	Supportive
		T	Non-Supportive
		WC	Non-Supportive
		Total	SUPPORTIVE
	% Increases	F to F	Slightly Supportive
		TC	Slightly Supportive
		T	Non-Supportive
		WC	Non-Supportive
	Volume	F to F	Non-Supportive
		TC	Supportive
		T	Slightly Supportive
		WC	Supportive
		Total	SUPPORTIVE
F to F = Face to Face			T = Teletype/Telegram
TC = Telephone Conversation			WC = Written Correspondence

ranking of each channel of the three utilization measures is supportive of the predicted rankings of the factors or variables of the two supporting hypotheses. It appears that of the predicted ranking of A_1 , A_2 , and A_3 for Project Alpha, all of the channels and the total of the combined weekly averages were supportive; of the percentage increase measure one channel was supportive, two channels non-supportive, and one channel not able to be ranked; and of the volume measure three channels are supportive, one channel slightly supportive, and the total volume was supportive. It appeared, then that in general, the three measures were supportive of the predicted rankings of the supporting hypotheses for Project Alpha.

It appeared that of the predicted ranking of B_2 , B_3 , and B_1 for Project Bravo, one of the channels of the combined weekly averages was supportive, three channels were non-supportive, however the total was supportive; two of the channels of the percentage increase measure were slightly supportive and two channels were non-supportive; and that two of the channels of the volume context were supportive, one channel was slightly supportive, one channel was non-supportive, and the total was supportive. The general picture that emerged for Project Bravo was one of moderate support for the pre-

dicted rankings of the supporting hypotheses by the three channel utilization measures, but not as strong supportive tendencies as those of Project Alpha.

Figures 8-1, 8-2 and Table 8-5, therefore, indicated that the three measures of channel utilization were, in general, supportive of the predicted rankings of the second and third hypotheses if the predicted rankings were A_1 , A_2 , A_3 for Project Alpha, and B_2 , B_3 , B_1 for Project Bravo. It was shown in a previous paragraph that the rankings of Supporting Hypothesis Two according to the uncertainty or factor of determinability of product or service was A_1 , A_2 , A_3 for Project Alpha, and B_2 , B_3 , B_1 for Project Bravo. The channel utilization measures, then, were in general support of the predicted relationships of the second supporting hypothesis.

Supporting Hypothesis Three was concerned with the factor or uncertainty of inter-organizational relationships. Two relationships were examined: (1) the extent of previous business transactions or dealings and, (2) the reliability and dependability in the sub organization's business practices. For the first of these relationships, it was predicted that for a first business relationship or transaction, the volume, frequency, and richness of communication channels would be higher than

for a well established prior relationship with numerous prior transactions. Table 8-1 indicated that the ranking of sub organizations from no previous transactions to numerous prior transactions was A_1 , A_2 and A_3 for Project Alpha and no ranking for Project Bravo because all were first dealings or transactions. The channel utilization measures of Figures 8-1, 8-2, and Table 8-5 were again in general support of the predicted relationships of this first inter-organizational relationship.

In the second inter-organizational relationship, it was predicted that for a sub organization demonstrating poor, unreliable, and non-dependable business practices, the volume, frequency, and richness of communication channels would be higher than for a sub organization demonstrating excellent, dependable, and reliable business practices. Table 8-1 indicated that the ranking of sub organizations from poor to excellent business practices was A_1 , A_2 , A_3 for Project Alpha and B_2 , B_3 , B_1 for Project Bravo. As in the case of the previous factors or uncertainties, the channel utilization measures of Figures 8-1, 8-2 and Table 8-5 were also in general support of the predicted relationship of this second inter-organizational relationship variable.

The factors or uncertainties described in these

two supporting hypotheses were apparently only two of a possible number of factors which influence and affect the degree of channel utilization between differing sets of transacting organizations. It was indicated by supportive evidence that these two factors tended to account for some of the variance in the degree of interpersonal channel utilization, but that they could not be proved to be causal factors in the varying utilization of interpersonal channels. The two supporting hypotheses, therefore, were not confirmed. In consideration of the examination and analysis of the data in this chapter, it appeared that the three measures of channel utilization only exhibited moderate support of and tendencies toward the predicted relationships of the two factors or uncertainties of determinability of product and inter-organizational relationships.

Additional or Other Factors of Channel Utilization

In the previous section of this chapter it was pointed out that the two factors or uncertainties of Supporting Hypotheses Two and Three were apparently only two of a number of possible factors or variables which influence or affect the degree of interpersonal channel utilization between differing sets of transacting organizations. Figures 8-1 and 8-2 also revealed that there

was a substantial amount of channel utilization that occurred between the periods of uncertainty examined or in the periods which were designated as the period of certainty in Chapter Seven. This section attempts to identify and discuss some of these "other" variables which could possibly account for an additional amount of the variance in the degree of channel utilization and identify and discuss the occurrence of channel utilization during non-trouble periods or periods of certainty.

It appears that there was a basic "noise" level or amount of interpersonal communication channel utilization in each set of transacting organizations and that this level or amount varied between each set of transacting organizations. Figures 8-1 and 8-2 visually indicated that there was a level of utilization of each channel that was continuous and consistent throughout the timespan of the project, and that this level was higher for some organizations than for others. It seems that it was necessary, whether in a period of problem uncertainty or in a period of certainty, for the transacting organizations to maintain some basic level or "noise" level of interpersonal communication. For some organizations, because of the experimental or advanced technological characteristics of the product or service, or

because of the tremendous dollar size of the contract, or because of a number of other relevant reasons, this noise level could be much higher than for the level between a set of organizations engaged in a small, rather unsophisticated, routine type of product or service. However, no matter what characteristics or factors are involved, it appeared that there was some necessary level or amount of continuous channel utilization essential to the functioning of each set of transacting organizations. It was like a nutrient solution that must be injected and maintained within the transacting set to facilitate stability and repairs and promote necessary growth and development in the basic relationships and transactions between the transacting organizations.

The project manager of prime organization B stated that some sub organizations made weekly telephone calls while others utilized the telephone conversation channel bi-monthly or monthly during the life of the project. These patterns were routine and continuous and did not occur irregularly or only during critical periods. He reported that this level of utilization was considered essential by these organizations for the purposes of information "trading" and for the successful functioning and completion of their projects and

contracts. The project personnel of prime organization A revealed that, in similar fashion, many of the sub organizations they dealt with made monthly trips, while others made quarterly visits to the prime organization on a routine or maintenance type of basis. They also reported that the written correspondence channel was used on a regular basis for the purposes of scheduled updatings and contract performance reporting and to document information transceived through other inter-personal channels.

It appears, therefore, that there was some basic level or amount of "noise" utilization in each set of transacting organizations and that this level varied in intensity for each individual set. This concept of "noise" level was one possible explanation of the varying degree of channel utilization between transacting sets and the occurrence of the channel utilization during non-trouble or non-critical periods of a project. The remainder of this section will identify and discuss other possible relevant factors or variables. However, it must be kept in mind that, in all probability, these factors or variables were not independent of one another but were interrelated to some degree and that they all possibly contributed in some measure to this basic "noise" level of channel utilization.

The interviews with the project manager and key project personnel of prime organization A suggested that some of the variation in utilization of the face-to-face channel could possibly be explained by "piggy-back" visits or "visits of opportunity". These were visits which occurred as add-ons and were not made for a specific reason or for the primary purpose of intended explicit interaction between the transacting organizations, but occurred as a result of one of the organizations visiting a non-project relevant organization located in the same general area as that of a relevant project transacting organization which resulted in an unplanned "visit of opportunity" with a relevant transacting organization. Of the four visits of $A \longleftrightarrow A_2$ which occurred during non-critical or problem periods, three occurred as a result of this type of factor or variable. Two were the result of a trip by the prime organization A to an organization located in a large industrial and research center for the primary purpose of discussing a completely different project than that of Project A. Sub organization A_2 was also located in this general area, and the prime organization personnel made a short visit to A_2 in each instance because of the close proximity of the organizations. The third visit of this type was made by sub

organization A_2 while one of their project personnel was interacting with another division of A on a different project and made a "courtesy call" on the project personnel of project Alpha "since he was in the general area". The project manager also stated that several of the instances of face-to-face communication with the monitoring organization A_m resulted from A's personnel being in the Washington D. C. area for a different purpose and making "visits of opportunity" to A_m while the project personnel were in that vicinity.

Another factor or variable which could possibly affect the channel utilization between periods of uncertainty was the monthly technical reports and quarterly design review and progress reports required by Defense Department monitoring and sponsoring agencies. A review of Figure 8-1 indicated that there was a very slight peak or increase in telephone and written channels approximately every three months for the transacting organizations of Project Alpha. The interview with prime organization A revealed that the quarterly reports usually necessitated telephone calls and occasionally visits with the sub organizations and monitoring organization and, of course, resulted in written correspondence with the latter organization. The monthly technical

reports usually resulted in only increased telephone and written channel utilization with the monitoring organization.

It also appears that location, related to climate and time of the year was another possible contributing factor or variable to degree of channel utilization between transacting sets and to frequency of utilization during non-trouble periods. A review of Figure 8-2 indicated that of the four designated periods of uncertainty for the transacting set $B \longleftrightarrow B_2$, there was no face-to-face interaction during two of these four periods. It was interesting to note that both the prime organization B and the sub organization B_2 were located in areas which were relatively inaccessible from an air transportation aspect. Additionally the time of year and its associated climate was particularly relevant to one of these periods of non-visits. Sub organization B_2 was located in the northeastern region of the United States. The first period of uncertainty in which there was no face-to-face interaction occurred during the four week period of 12 January to 8 February, usually the coldest and most hazardous winter months of the year for the region B_2 is located in. It appeared, therefore, that location, along with time of year and climate could be

an important factor in face-to-face channel utilization.

The explicit or implicit travel policy of the prime organizations appears to be another possible contributing factor or variable to channel utilization. The interviews with the project personnel of the prime organizations of both projects indicated that the basic or general travel policy of the two organizations were somewhat different. The project personnel of A explicitly and pointedly described a policy which encouraged travel and fostered the utilization of the face-to-face channel. The project personnel of B, however, did not describe a similar policy as that of A, but did not describe a restrictive policy of travel either. They described a policy which neither explicitly encouraged or discouraged travel, but implicitly tended toward the restrictive side. Both the visual presentations of Figures 8-1 and 8-2 and the numerical volume presentation of Tables 8-2 and 8-3 indicated that the face-to-face channel utilization of all the transacting organizations of Project Alpha was markedly higher than the face-to-face channel utilization of the transacting organizations of Project Bravo. It appears that the basic travel policy of the prime organization possibly influenced the travel policy of the relevant sub organi-

zations and permeated throughout the project. The face-to-face utilization patterns of Projects Alpha and Bravo were highly supportive of this probable factor or variable.

The final factor or variable possibly contributing to the degree of channel utilization discussed in this section was the cost or dollar size of the project and the sub contracts placed with sub organizations. It appears that the total cost of the project and the dollar size of the sub contracts were both possibly related to the degree of channel utilization. Chapter Six revealed that the costs of the projects were:

<u>Project Alpha</u>		<u>Project Bravo</u>	
Total Cost	\$5.5 million	Total Cost	\$1.3 million
A ₁	\$179,000	B ₁	\$100,000
A ₂	110,000	B ₂	61,000
A ₃	53,000	B ₃	26,000

These figures showed that the total cost of Project Alpha was over four times larger than that of Project Bravo. Both the graphs and the tables indicated that there was much higher frequency of utilization and total volume of channel utilization for Project Alpha than for Project Bravo. The transacting sets of organizations of Project Alpha, according to dollar size of contract, ranked A₁, A₂ and A₃, and, in the preceding section, it was indicated

that the rank of the organizations according to frequency of utilization, percentage increase, and volume of utilization was A_1 , A_2 , A_3 . It was interesting to note, however, that the sub organizations of Project Bravo did not follow a similar pattern of correlation. According to dollar size, the sub organizations ranked B_1 , B_2 , B_3 and according to the three measures of utilization ranked B_2 , B_3 , B_1 .

This section has attempted to identify and discuss some of the additional or other possible factors or variables which could account for an additional amount of the variance in the degree of channel utilization and account for the frequency and anomalies of utilization during non-trouble periods. Several factors or variables have been introduced and, when relevant, supportive relationships indicated by the visual graphs or numerical tables have been shown. These are but a few of the possible number of factors or variables which contributed to the degree of utilization between transacting sets of organizations.

Summary

The analysis and investigation of the two types of factors or uncertainties, determinability and complexity of product or service and inter-organizational

relationships, showed that Supporting Hypotheses Two and Three could not be confirmed. It appeared from the examination of these two factors or uncertainties that they were not independent of each other and were probably only two of the possible factors or variables which influenced and affected the degree of channel utilization patterns between different sets of transacting organizations of a common research and development project. The results of the analysis and investigation indicated that the two factors or uncertainties studied accounted for some of the variance in the degree of interpersonal channel utilization, but that they could not be proved to be the only or dominating factors in the varying utilization of interpersonal channels. It appeared that the three measures of channel utilization examined in this chapter exhibited only moderate support of the hypothesized relationships of the two factors or uncertainties introduced in Supporting Hypotheses Two and Three. In addition, this chapter identified and discussed some of the other possible factors or variables which could account for an additional amount of the variance in the degree of channel utilization between transacting sets of organizations and could explain the frequency and anomalies of individual channel utilization during non-trouble periods.

In the next chapter, the synthesis and implications of these findings and those of Chapter Seven will be discussed.

PART V

SUMMARY, DISCUSSION, AND CONCLUSIONS

CHAPTER NINE

SUMMARY, DISCUSSION AND CONCLUSIONS

Some of the points I make may arouse a shock of recognition, a feeling that here is something which the reader knew all along. This is the way it should be. The analysis of one's own society and culture simply makes explicit the many things we take for granted in our everyday lives. Talking about them, however, changes our relation with them. We move into an active and understanding correspondence with those aspects of our existence which are all too frequently taken for granted or which sometimes weigh heavily on us. Talking about them frees us from their restraint.

- Edward T. Hall (1959)

I. SUMMARY AND GENERAL FINDINGS

Summary

This study was aimed at enlarging the understanding of the interface between research and development organizations and the process of information transfer and diffusion within the scientific and technical communication system. The focus of this research was upon the utilization of interpersonal communication channels between transacting organizations engaged in a research and development project under varying project conditions.

Empirical user studies of the communication behavior patterns of individual scientists and engineers have shown that the interpersonal or informal channels

perform several essential functions and are of great importance to individual scientists and engineers engaged in research and development. One of the most important and essential functions is the exchange of ideas and information with other scientists and engineers to solve mutual research and development problems and to find solutions to failures and negative results. Additionally, these user studies have suggested that individual scientists and engineers have a preference of channel usage among the interpersonal channels and that this preference and need intensifies when critical problems arise or when information is required that is difficult to obtain.

The research study for this dissertation was carried out in terms of inter-organizational communication by investigating the utilization of interpersonal channels between the key personnel (scientists and engineers) of a prime organization and the key project scientists and engineers of relevant sub organizations engaged in a research and development project. The personnel of each transacting organization were considered in the aggregate as a communication entity, enabling the investigation of inter-organizational channel utilization. The major premise of this study was that the

utilization of interpersonal communication channels between the transacting organizations of a research and development project is directly related to the varying project uncertainties.

Two basic types or categories of project uncertainties were identified: (1) uncertainties arising from unforeseen or unexpected technical, budgetary, administrative, and contractual project problems between a prime organization and a sub organization, and (2) uncertainties arising from the product or service rendered and inter-organizational relationships. The interpersonal communication channels studied were: face-to-face interactions, telephone conversations, teletype/telegram messages, and written correspondence.

The concept of "richness of communication" was developed to describe and analyze the four different interpersonal communication channels. This concept is in correspondence with the need and preference, described above of the four interpersonal channels of individual scientists and engineers, which intensifies when critical problems arise. This concept pertains to two basic characteristics of the interpersonal channels. First, it relates to the technical and mathematical capacities inherent in the four channels. This characteristic

includes the limits of symbol transmission, the speed by which the channel can transmit and exchange information, noise to signal and distortion ratios, number of coding processes available, and the mathematical capacities not concerned with meaning. The second characteristic relates to the capability of the channel to communicate true meaning. This includes the feedback capabilities, the ability to separate unintended meaning and cognition from the intended meaning, and the capability to attain co-orientation and perfect correspondence between sender and receiver. Together, these two capabilities or characteristics form a discriminate measure of richness of communication. Ranking the four interpersonal channels on a scale of richness, the richest channel would be face-to-face interaction, followed in a sequence of decreasing richness by telephone conversation, teletype/telegram messages, and written correspondence.

Specifically, the research was designed to answer the following three questions with respect to the major premise of this study stated above:

1. Is the utilization of interpersonal communication channels between the prime organization and the sub organizations of a research

and development project a function of uncertainties arising from unforeseen or unexpected project problems?

2. Does the determinability and complexity of products or services between the transacting project organizations relate to the utilization of the interpersonal channels?
3. Is interpersonal channel utilization between project organizations related to the nature and characteristics of inter-organizational relationships?

Data were obtained from the prime organizations of separate research and development projects funded and sponsored by the Department of Defense. The first project consisted of a large, industrial, profit making prime organization, three sub organizations (sub contractors/vendors), and a government monitoring/sponsoring organization. The prime organization was located in a large metropolitan and industrial area which is one of the major transportation and communication centers in the United States. The second project consisted of a medium size, non-profit prime organization and three relevant sub organizations. The second prime organization was located in a relatively small metropolitan area

which is neither a communication nor transportation center.

Data from the archival business and administrative records of the prime organization of each of the two projects were used to compile descriptive statistics, graphic presentations, and measures of the utilization of interpersonal communication channels between the transacting organizations of each project. Data obtained by interviews with the key project personnel of each prime organization were used to compile project histories and to derive and designate periods of project problem uncertainties, determinability and complexity of products or services between differing sets of transacting organizations, and the nature and characteristics of two inter-organizational relationships between differing sets of transacting organizations. Statistical analysis was limited to non-parametric methods which do not require the assumptions of interval measurement and normal distributions. Channel utilization and project uncertainties were measured on an ordinal scale and the distribution of the frequency and volume of each interpersonal channel were not tested to determine normal distribution or homoscedasticity. The data developed from the unobtrusive measurements and the interviews were used

to examine three supporting hypotheses derived from the major premise of this study. The results of this analysis and investigation were discussed in terms of these supporting hypotheses and the basic hypothesis.

Supporting Hypothesis One

SH-1 Interpersonal communication channel utilization between the transacting organizations is a function of the uncertainties arising from project problems such as: unforeseen or unexpected technical, budgetary, administrative, and contractual problems. It is expected that channel utilization will increase with the occurrence of anyone of these types of problems and that there will be, concurrently, an increase in the use of the richer channels of communication.

Changes in interpersonal channel utilization were examined and analyzed in terms of three measures: (1) is there a one-to-one correlation between periods of uncertainty and increased frequency of utilization of the interpersonal channels; (2) is the average weekly frequency of the individual channels of the transacting sets of organizations greater during periods of uncertainty; and (3) are the percentage increases in utilization of the individual channels during periods of uncertainty for a transacting set progressively larger for the richer communication channels?

The data showed an apparent one-to-one correlation between periods of uncertainty and increased frequency

of utilization of the interpersonal communication channels in twenty one of the twenty seven individual inter-organizational channels. Of the six inter-organizational channels that did not indicate a one-to-one correlation, the written correspondence channel accounted for four of the instances and the teletype channel the remaining two. Both are the least rich of the four types of interpersonal communication channels. The average weekly frequency of utilization of channels was higher during periods of uncertainty than during periods of certainty in twenty three of the twenty seven individual inter-organizational channels. Of the four channels that did not indicate a higher average, three occurred in the written correspondence channel and one occurred in the teletype channel, again the least rich of the four types of channels. The face-to-face and the telephone conversation channels ranked 1, 2 in richness utilization according to the percentage increase in utilization of channels during periods of uncertainty in all seven of the transacting sets of organizations. And in five of the seven sets face-to-face interaction, telephone conversation, teletype messages, and written correspondence ranked 1, 2, 3, 4. Thus the findings were in support of the first supporting hypothesis and it was concluded that inter-

personal channel utilization between the transacting organizations is a function of uncertainties arising from unforeseen and unexpected project problems.

Supporting Hypotheses Two and Three

SH-2 Interpersonal communication channel utilization between the transacting organizations is a function of the variation in determinability and complexity of products or services. It is expected that for a non-routine, one-of-a-kind, undeterminable product or service, the volume, frequency, and richness of communication channels will be higher than for a routine, catalogue, or highly determinable product or service.

SH-3 Interpersonal communication channel utilization between the transacting sets of organizations is a function of the nature and length of the inter-organizational relationships between the project personnel of the prime organization and the various sub organizations. It is expected that a prior established relationship or one of excellent business reliability and dependability will result in lower volume, frequency, and richness of communication channels than for a new relationship or one of poor business practices or reliability.

The three sub organizations of each project were ranked according to the two types of uncertainties or variables of the second and third supporting hypotheses, determinability of product and inter-organizational relationships. The four interpersonal channels utilized by the three sub organizations of each project were ranked according to three measures of channel utilization:

(1) average weekly frequency of utilization during periods of problem uncertainties, (2) percentage increases in utilization during periods of project problem uncertainties, and (3) volume of channel utilization.

The study was designed to examine and test each supporting hypothesis separately by finding if the ranking of each channel of the three utilization measures was supportive of the predicted ranking according to the factors or variables of the two supporting hypotheses. However, the results of the analysis and examination of the data indicated that the two types of factors or uncertainties, determinability of product or service and inter-organizational relationships, were not independent of each other and were probably only two of a possible number of factors or variables which influence and affect the degree of channel utilization patterns between different sets of transacting organizations of a common project. The results indicated that the two factors or uncertainties tend to account for some of the variance in the degree of interpersonal channel utilization, but that they cannot be confirmed to be causal factors in the varying utilization of interpersonal channels. Thus, the findings of the three contexts of channel utilization examined moderately supported the predicted relationships of the two factors or uncertainties identified in Supporting Hypotheses Two and

Three.

Basic Hypothesis

The results of this study have partially confirmed the major premise or basic hypothesis of this study which is:

Interpersonal communication channel usage between the transacting organizations engaged in a research and development project is a function of project uncertainties. That is, interpersonal communication channel utilization between the transacting organizations as measured by frequency, volume, and richness of channel, will vary directly with the degree of project uncertainties.

It has been moderately supported in that Supporting Hypothesis One was confirmed. It was concluded that interpersonal channel utilization between the transacting prime and sub organizations of a project is a function of uncertainties arising from unforeseen or unexpected project problems. Furthermore, the results of the investigation moderately supported the predicted relationships of the two types of uncertainties identified in Supporting Hypotheses Two and Three, even though they could not be confirmed.

General Findings

A number of general findings relevant to the communication ↔ organization interface have emerged from the analysis and examination of the data of this study. Four of these findings may be considered as the major or

most significant findings of this study.

1. The basic hypothesis or major premise of this study was moderately supported. This finding indicates that interpersonal channel utilization between transacting organizations is directly related to project uncertainties, in general.

2. It appears that the uncertainties of determinability of product or service and inter-organizational relationships are two of a possible number of types of uncertainties or factors which influence and affect the degree of total interpersonal channel utilization between different transacting organizations of a common project. Though the results indicate that these two factors do account for some of the variance in and are directly related to the degree of interpersonal channel utilization between different sets of transacting organizations within a common project, these two types of uncertainties or factors could not be confirmed to be causal factors.

3. The confirmation of the first supporting hypothesis results in the conclusion that interpersonal channel utilization between a transacting set of prime and sub organizations is a function of the uncertainties arising from relevant project problems. A period of uncertainty was identified with each type of project problem which arose. The general picture that comes into

view consistently throughout the analysis of the data of this study is one of markedly increasing utilization of interpersonal communication channels during these periods of uncertainty.

4. The strongest feature that emerged regularly, pointedly, and very discernibly throughout this study is the increased utilization and evident reliance on the face-to-face channel and the telephone conversation channel during periods of project problem uncertainty, with the strongest emphasis and reliance placed on the face-to-face channel. The data have shown that in every one of the transacting sets of organizations of both projects, the face-to-face channel followed by the telephone conversation channel are the only channels which: (1) have one-to-one correspondence between periods of uncertainty and increased frequency of channel utilization, (2) have the average weekly frequency of utilization higher during periods of uncertainty than during periods of certainty and (3) respectively rank 1, 2 according to the greatest percentage increase in utilization during periods of uncertainty. This consistent pattern of the face-to-face channel having the highest usage and the telephone conversation channel the next highest corresponds directly with the concept of richness

of communication and indicates that the reduction of project problem uncertainties is carried out mainly through the utilization of the face-to-face channel first and the telephone conversation channel second.

Several additional findings which have emerged through the analysis and examination of this study that are relevant to the subject of inter-organizational communication are as follows:

5. It appears that there are definite gradations in the rate of increase and decrease of utilization of the face-to-face and telephone conversation channels. There is a gradual crescendo rise in the utilization of these two channels as a period of uncertainty germinates and is recognized, the constant increase continues until it reaches a high point, and then drops off rapidly and sharply as the period of uncertainty wanes.

6. There is an apparent trade-off function between the face-to-face and telephone conversation channels during periods of uncertainty. It appears that there is some necessary quantity-quality total of communication between the transacting organizations required during these periods, and that some combination of utilization of the two channels is required. When the frequency of utilization of the face-to-face channel

is relatively low, there is an apparent increase in the frequency of utilization of the telephone conversation channel during these critical periods. Similarly, when the frequency of utilization of the telephone conversation channel is relatively light, there appears to be a substantial increase in the frequency of utilization of the face-to-face channel during these periods of uncertainty.

7. There is an apparent inter-relationship of communication patterns or behavior between the prime organization ↔ sub organization and the monitoring organization. It appears that when a critical period of uncertainty arises, there is an increase in the utilization of the interpersonal channels not only between the prime organization and the relevant sub organization experiencing this critical period of uncertainty, but also simultaneously an increase in channel utilization between the prime organization and the monitoring or sponsoring organization.

8. It appears that there is a basic level or amount of interpersonal communication channel utilization in each set of transacting organizations and that this "noise" level varies in intensity for each individual set of transacting organizations. No matter what

project characteristics or technical factors are involved, whether in a period of problem uncertainty or in a period of certainty, it seems that there is some necessary noise level or amount of continuous channel utilization essential to the functioning of each set of transacting organizations.

9. It appears that in addition to the uncertainties or factors of determinability of product or service and inter-organizational relationships identified in finding 4 above, there are other factors or variables which account for an additional amount of the variance in the degree of channel utilization between differing sets of transacting organizations and can help explain the frequency and anomalies of individual channel utilization during non-trouble periods or periods of certainty. These additional factors which are not sources of uncertainty include "piggy-back" visits or "visits of opportunity", the periodic technical and design review/progress reports required by the monitoring and sponsoring organization, location of organizations related to climate and time of year, explicit or implicit travel policy of the transacting organizations, and total cost of the project along with the dollar size of contracts placed with sub organizations.

II. A MORE GENERALIZED LOOK AT REDUCTION OF UNCERTAINTY THROUGH INTERPERSONAL CHANNEL UTILIZATION

This section is an attempt to develop a possible general theoretical explanation or framework for some of the empirical findings of this study relevant to the reduction of uncertainty through the utilization of interpersonal communication channels. The data obtained in the course of this study have shown that for every transacting set of organizations there is some regular level of interpersonal channel utilization throughout the life of the project and that there are some non-regular peaks or periods where channel utilization increases markedly over the normal utilization level. Furthermore, the findings of this study indicate that for a transacting set of organizations there are periods of certainty or non-trouble and periods of uncertainty; and that the regular level of interpersonal channel utilization appears to be a basic "noise" level or amount that is essential to the continuous functioning of the transacting set and is visible during the non-trouble or certainty periods. The findings indicate that the increased utilization or peak periods are directly related to periods of uncertainty arising from relevant project problems.

General Background and Findings of the Reduction-of-Uncertainty ↔ Increased-Channel-Utilization Interface

The periods of uncertainty that are directly related to increased interpersonal channel utilization are periods emerging as a result of project difficulties such as: unforeseen or unexpected technical, budgetary, administrative, or contractual problems - the out-of-the-ordinary events or situations which occur. In the communication ↔ organization interface, Fiedler (1968) identifies these periods of uncertainty as crisis periods: "By definition, a crisis period implies a situation that does not provide ordinary guidelines for behavior" (p.373). Fiedler further suggests that in business organizations during a crisis period, the usual or normal response is increased utilization of direct interpersonal interaction to aid in the alleviation or reduction of the crisis or uncertainty. Fiedler states that:

The typical response for business organizations during crisis periods is for the manager to call his key personnel together for consultation, decision-making, and problem-solving tasks. After the crisis period has passed the organization generally returns to routine and fairly well structured tasks (1968, p. 373).

Many of the empirical user studies of the individual communication behavior of scientists and engineers have shown that these individuals rely on the interpersonal channels to solve mutual research and development

problems and find solutions to failures and negative results. Additionally, these user studies have shown that the individual scientists and engineers have a hierarchy of channel usage preference and that this preference and need intensifies during crises or uncertain periods when critical problems arise and reduction of these problems is required. The hierarchy of channel usage preference is face-to-face interaction first, and telephone conversation to supplement face-to-face interaction or to be utilized when face-to-face interaction is not possible.

The strongest pattern emerging from the data collected in the course of this study is the definite and very pointed increase in the utilization and evident reliance on the face-to-face channel and the telephone conversation channel during periods of project problem uncertainty, with the strongest emphasis and reliance placed on the face-to-face channel. These findings indicate that the reduction of project problem uncertainties of a set of research and development transacting organization is carried out primarily through the utilization of the face-to-face channel and secondarily through the utilization of the telephone conversation channel, the richest channels of communication. Also this study has indicated that there are types of uncertainties or factors

which continually influence and affect the degree of channel utilization between the prime organization and one sub organization, and the prime organization and another sub organization. These types of uncertainties or factors influence and affect the level of channel utilization over the life of a project, both during periods of uncertainty and during periods of certainty. Again, the reduction of these types of continuous factors or uncertainties is accomplished primarily through the face-to-face channel and secondarily through the telephone conversation channel.

Reduction of Uncertainty by Means of the Most Efficient Channels of Interpersonal Communication

What then is the explanation of the behavior in business organizations which Fiedler described as the "typical response" to a period of uncertainty or crisis? Why does a manager call his key personnel together for face-to-face interaction when the threat of a crisis or uncertain period is perceived? Why do individual scientists and engineers rely primarily on the face-to-face channel to solve problems and increase the utilization of the channel during periods in which failures or negative results have occurred? Further, why do research and development transacting organizations utilize, empha-

size, and rely primarily on the face-to-face channel and secondarily on the telephone conversation channel during periods of project problem uncertainty and utilize these channels regularly throughout the life of a project?

The most obvious cause of this increase and reliance on face-to-face interaction and direct verbal interaction is the need for efficient and expedient communication and exchange of information which is required for the solution of problems and the making of decisions to eliminate or reduce the crisis situation or uncertain period. It is the motivational force and requirement to reduce or eliminate the period of crisis or uncertainty by exchanging efficient information and by efficiently converting the raw data into information which can be communicated. MacKay (1964) has shown that a "message provides information only insofar as it reduces uncertainty and the amount of information is determined by the amount the uncertainty is reduced by the message" (p. 172). Thayer (1967) suggests that it is not the things of the world - material or non-material - with which individuals deal but it is the information about those things. The process of communication is "the event or occurrence of consciously or unconsciously ascribing meaning or significance to raw sensory data

and thus of converting it to information" (p. 39).

The findings of this study, as well as Fiedler's study of business organizations and the user studies of individual scientists and engineers, indicate that this relevant and required information is provided and exchanged primarily through the face-to-face channel and secondarily through the telephone conversation channel which are, respectively, the richest and most efficient of the four interpersonal channels. Chapter Three discussed, in detail, the characteristics and capabilities of these two channels which result in their efficiency, effectiveness, and richness. This efficiency related to the technical and mathematical capacities inherent in the channels and to the capability of the channels to communicate true meaning. The first characteristic includes the limits of symbol transmission, the speed by which the channel can transmit and exchange information, the technical capacities, noise to signal and distortion ratios, number of coding processes available, and the mathematical capacities not concerned with meaning. The second characteristic includes the feedback capabilities, the ability to separate unintended meaning and cognition from the intended meaning, and the capability to attain co-orientation and perfect correspondence between sender

and receiver. Thus, the conversion of raw sensory data into information and the efficient/expedient exchange and provision of the information, through the utilization of the face-to-face channel and secondarily the telephone conversation channel for the accomplishment of the problem solving and decision making tasks, aids in the reduction and alleviation of the crisis situation or the period of uncertainty.

Reduction of Uncertainty Through Interpersonal Channel Utilization - A Social Psychological Framework

There is a less obvious, but nevertheless relevant and important, social psychological contribution to the explanation of reduction of uncertainty by increased utilization of face-to-face interaction and direct verbal communication. This explanation is found in the theories of social comparison, opinion evaluation, and affiliation in stressful situations. This section develops an argument that the basic nature of research and development projects results in a certain degree of uncertainty present in all phases of a project and that individuals concerned with this uncertainty will seek affiliation and face-to-face association with other individuals in similar situations or who are close to them in opinions and abilities, and through this evaluation will reduce the

uncertainty and will attain satisfaction. Additionally, during specific periods of project problem uncertainty, the project personnel ordinarily perceive the problem as a crisis or stressful situation and attempt to reduce this uncertainty through affiliation and face-to-face interaction with individuals in a similar situation. This is in response to needs for self evaluation of their own emotional reactions, direct anxiety reduction, and dependency-motivation.

Previously in this dissertation, uncertainty was related to project problems and specific situations which were out-of-the ordinary situations, and it was shown that increased face-to-face channel utilization is a function of these periods of uncertainty. It was also indicated that there is a basic and continuous "noise" level of channel utilization in each set of transacting organizations throughout the timeframe of the project and that this level of utilization is evident during the non-trouble periods or the so called periods of certainty. This social psychological framework will attempt to aid in the explanation of both the face-to-face channel utilization during these periods of certainty and the increased utilization and reliance on the face-to-face channel during specific periods of uncertainty.

In attempting to contribute to the explanation of the face-to-face channel utilization during the so called periods of certainty, it is necessary to recognize that there is some apparent amount of uncertainty present in any time period or timespan of a research and development contract. The analysis of Chapter Eight indicates that there are types of uncertainties which continually act on a transacting set of organizations throughout the project life and which affect and influence the total intensity or level of channel utilization in both periods of certainty or non-trouble and periods of uncertainty. The basic nature of research and development projects results in a certain degree of uncertainty present in all phases of a project. The process of researching and developing new technical, creative, and innovative systems and equipment which are highly sophisticated and technologically advanced lends itself to a basic degree of uncertainty, whether in a certain or uncertain period. Additionally, even during the periods when there are no specific project problems, the scientists and engineers of the transacting organizations will not be totally certain of the correctness, validity, and soundness of their opinions, abilities, and methodological procedures.

Festinger (1954), in his theory of social comparison

processes, developed a strong basis for group face-to-face interaction and affiliation when he hypothesized that: (1) there exists in the human organism, a drive to evaluate his opinions and abilities. A person's cognition about the situation in which he exists and his appraisals of what he is capable of doing (his evaluation of his abilities) will together have bearing on his behavior. (2) To the extent that objective, non-social means are not available, people evaluate their opinions and abilities by comparison, respectively, with the opinions and abilities of others. (3) Given a range of possible persons for comparison, someone close to one's own ability or opinion will be chosen for comparison. (4) A person will be less attracted to situations where others are very divergent from him than to situations where others are close to him in both opinions and abilities. (5) The stronger the attraction to the group, the stronger will be the pressure toward uniformity concerning abilities and opinions within the group.

From this theory, Festinger was able to derive implications for group association and societal structure. He proposed that the drive for self evaluation concerning one's opinions and abilities has implications not only for the behavior of persons in groups but also

for the processes which bring people together and for the process of group formation and changing membership of groups. To the extent that self evaluation can only be accomplished by means of comparison with other persons, the drive for self evaluation is a force acting on persons to associate with others in face-to-face interaction, to belong to groups. And the subjective feeling of correctness in one's opinions and the subjective evaluation of adequacy of one's performance on important abilities are some of the satisfactions that persons attain in the course of these associations with other people.

Radloff (1961) applied and extended Festinger's implications of self evaluation and social comparison in experimental studies in which he tested the hypothesis that a person's needs for self evaluation regarding the correctness of his opinions and abilities arouse affiliative tendencies in him. He demonstrated through the means of experimental evidence that needs for evaluation of opinions and abilities are important determinants of association and affiliation. Radloff's major hypothesis is that a person who is uncertain about the correctness of one of his opinions, for which he finds no objective criteria available by which to evaluate its

correctness, should seek affiliation with other people in order to evaluate his opinion via social comparison. The theoretically significant contribution of his study is the demonstration that the affiliative consequences of evaluative need are apparently applicable in a variety of seemingly disparate contexts. That is, whenever evaluative needs, with respect to opinions, capable of being satisfied by social comparison are aroused, the arousal of affiliative tendencies is a potential consequence. The arousal of affiliative needs concerning abilities also produce affiliative tendencies in the absence of adequate non-social means of evaluation.

The implications of Festinger's theory, then, together with Radloff's applications and findings suggest a framework which contributes to the explanation of face-to-face channel utilization between transacting sets of organizations during periods of certainty or non-trouble. It was indicated above that even during the so called periods of certainty there is some degree of uncertainty because of the basic nature of research and development; and that when there are no specific project problems the project personnel normally have some degree of uncertainty about the correctness and soundness of their opinions, abilities, and technical or scientific methods and

procedures. Festinger and Radloff have indicated that a person who is uncertain about the correctness of one of his opinions or abilities will seek affiliation and face-to-face association with other people in similar situations or who are close to him in opinions and abilities, and through this evaluation will reduce this uncertainty and will attain satisfaction in the course of these face-to-face associations or interactions.

This framework of Festinger and Radloff also contributes to the explanation of the increased utilization and evident reliance on the face-to-face channel during specific periods of project problem uncertainty. These periods are specific, out-of-the-ordinary situations which arise from definite problems such as a design or technical enigma or impasse which results in unforeseen time delays, increasing costs, or sometimes a cancellation of sub contracts. These specific situations or uncertain periods result in the arousal of anxiety, emotional tension, and emotional uncertainty in the project personnel of transacting organizations involved in the relevant project problem. Fiedler classifies these periods as crisis periods, and in a psychological framework, these specific periods of uncertainty are classified as stressful events.

Holtzman and Bitterman (1956) have classified

stimuli or factors which are common to all stressful situations. These include: (1) distractions, criticisms, and time pressures; (2) real, contrived, or anticipated failure; and (3) situations threatening the individual's security (anticipated threat or danger). Lazarus (1966) points out that the major intervening variable in the analysis of psychological stress is the concept of threat. That is, threat is anticipatory since it involves the expectation of future discomfort and harm and is dependent upon cognitions. Wrightsman (1960) refers to anxiety arousal as a feeling of uneasiness or concern about participating in an impending unpleasant event; unlike generalized anxiety, it is conceived as linked to a specific situation. Basowitz, Persky, Korchin, and Grinker (1955) advocate using the term "stress situation" to refer to stimulus conditions which are assumed to arouse an affective response of anxiety in an individual. Janis and Leventhal (1968) propose a more general definition of stressful situations. Any change in the environment which typically induces a high degree of emotional tension and interferes with normal patterns of response is a stressful event.

During these periods of uncertainty or stress, the project personnel will continue to have some degree

of doubt or arousal of uncertainty about the correctness of opinions and abilities and will seek affiliation and association with other project personnel in order to evaluate their opinions and abilities via social comparison. Radloff demonstrated that the affiliative consequences are applicable in a variety of seemingly disparate contexts. It was indicated that this framework was applicable to the so called periods of certainty or non-trouble, and, accordingly, it is apparently applicable to this context of uncertain periods and situations of project problems. This context, however, is significantly different from the context of certainty or non-trouble in that these periods or situations are stressful situations which arouse anxiety and emotional tension and uncertainty in the relevant project scientists and engineers.

Schachter (1959) found a positive relation between emotional arousal and affiliative tendencies; specifically, under conditions of experimentally manipulated anxiety, highly anxious individuals wanted to be with others more than did nonanxious individuals. Also, he found that under conditions of anxiety the affiliative tendency is highly directional. That is, whatever the needs aroused by the manipulation of anxiety, the satis-

faction of emotional arousal in anxious persons demands the presence of others in a similar situation. Schachter suggested five mechanisms that could possibly be responsible for affiliative responses under stress:

1. Escape. Individuals may want to be together as a way of getting out of the crisis situation - "safety in numbers".

2. Cognitive clarity. In ambiguous or novel situations, forces arise that impel people to associate with other people as a means of achieving some degree of clarity about an otherwise incomprehensible event.

3. Indirect anxiety reduction. One of the most effective devices for anxiety reduction is simply to get one's mind off one's troubles. Movies, television, and mystery stories are devices that elegantly serve as this diverting function. And people can be the best of diverters, for not only may they be more entertaining and distracting, but also they can effectively compel attention more than most other distractors.

4. Direct anxiety reduction. People do serve a direct anxiety reducing function for one another. They comfort and support, they reassure one another and attempt to bolster courage. Since anxiety is an unpleasant state, it is possible that highly anxious individuals affiliate

as a means toward social reassurance and toward reducing anxiety.

5. Self evaluation. Just as one compares himself to other people as a means of establishing a framework and social reality for his opinions, so one may use other people to evaluate his emotions and feeling. That is, the arousal of any strong emotion evokes a need for comparison. Emotions are assumed to be quite unspecific states of affect. Hence, persons can only evaluate the quality, intensity, and appropriateness of their emotions properly by comparing their own reactions with those of others. Moreover, novel emotion producing stimuli should induce a greater tendency to affiliate than familiar stimuli. By definition, a novel stimulus is one that is more difficult to fit into a person's established frame of reference for emotive states. Accordingly, the individual is more obliged to seek out others in order to define the emotional effects of novel stimuli.

As a result of his experiments, Schachter was able to rule out the first three of the above five mechanisms or reasons for the anxiety \longleftrightarrow affiliative relationship, and concluded that an anxious subject's desire to be with others is determined by mechanism (4) needs for direct reduction of anxiety, and/or (5) needs for

evaluation of one's emotional state. Schachter utilized Festinger's theory of social comparison to aid in accounting for the arousal of affiliative tendencies when an individual is exposed to stress. That is, the emotions or feelings of a individual, like the opinions and abilities, require social evaluation when the emotion producing situation is ambiguous or uninterpretable. And when discrepancies of emotional state exist, tendencies will arise to bring oneself into closer conformity with others, to change others, and to reject deviates as comparison points. The results of Schachter's research indicates a direct relationship between anxiety and affiliative tendency, that this relationship maintains itself under a range of conditions from complete freedom of verbal communication to complete absence of verbal communication, and that the relationship is highly directional and specific to people in similar plights.

Since Schachter's pivotal experiments (1959), other experimental social psychologists have conducted research to verify empirically his findings and conclusions of affiliation needs and tendencies under stress or crisis situations. Some have examined both his affiliative mechanisms of direct anxiety reduction and self evaluation, others have examined one or the other.

Wrightsmann (1960) found that a person does evaluate his level of anxiety through the process of social comparison and that level of anxiety shares with opinion the feature of being partially determined by cognitive processes and leads to affiliation. He also found that if persons are anxious, being with others is more effective in reducing their anxiety than is being alone. The results of his research are in correspondence with both of Schachter's findings. Another of Wrightsmann's findings indicate that anxious individuals desire to be with others even when verbal communication is not permitted. When his subjects were placed in a situation without verbal communication, where only the sheer physical presence of others were available, they responded with a greater reduction in anxiety than occurred in similar individuals who were placed alone.

Sarnoff and Zimbardo (1961) experimented with threat or fear anxiety and found that when fear anxiety is aroused, and an individual is unable to flee from the threatening object or situation, the individual welcomes the opportunity to affiliate. The greater the threat or fear aroused, the more the individual chooses to be together with others while they await the contact with the fear arousing event or object. Gerard and Rabbie (1961)

used a modified version of Schachter's fear arousing situation to evaluate the intensity of emotion to a stressful situation. They suggested that a number of kinds of internal cognitive unclarity regarding an aroused state may exist: the individual may want to label the emotion, measure its intensity, determine whether it is appropriate, or discover whether or not he is reacting adaptively to the impending situation. Support was found for the theory that the individual is motivated to compare with others, through affiliation, his intensity of an emotional experience whenever other means of achieving certainty about that intensity are lacking. Gerard (1963) conducted an experiment to test an assumption, basic to self evaluation, that an uncertainty evaluation regarding some aspect of the self, such as an emotional experience, produces a desire to compare one's self with others. His findings suggest that uncertainty does produce a desire to compare one's self with others, and that the individual's uncertainty, relative to available comparison persons, will determine his comparison tendency.

Janis (1963) suggests that it has long been known that when people are exposed to threat and danger they show a remarkable increase in some form of group solidarity. That is, they manifest increased motivation

to retain affiliation with a face-to-face group of people and to avoid actions that deviate from its norms. His research supports the hypothesis that additional needs for reassurance are directly stimulated by the threat of danger or fear, and that these needs are satisfied through face-to-face interaction with a group. Latane, Eckman, and Joy (1966) found that interpersonal attraction in a stress situation can be explained simply by the fact that in many situations people who are undergoing stress together do something for one another that serves to alleviate the stress. People in an uncomfortable situation provide a direct service for each other by reducing each other's fear and anxiety. The presence of other people does have a calming influence through direct reassurance and comforting. Their findings also suggest that a relevant function which people under stress may serve for each other is that of providing a means of evaluating just how much distress they are suffering. When faced with the prospect of undergoing a disagreeable experience, persons prefer being with somebody else who is also threatened with the same experience to being alone.

The findings of Darley and Aronson (1966) indicate support for both of Schachter's mechanisms of

affiliation. Their experimentation suggests that self evaluation and direct anxiety reduction both motivate the affiliation desires of individuals and that social comparison is a relatively more important determinant of the affiliation choice than direct anxiety reduction. Concerns for anxiety reduction, either directly, through contrast, or a desire for self reassurance by reassuring others, do not seem to have as strong an effect on stressful individuals as social comparison needs.

The bulk of the research and experimentation of affiliative preference under stress has focused on Schachter's hypotheses of direct anxiety reduction and self evaluation motives or drives. However a third hypothesis has been formulated and tested that affiliation under stress might also be produced by a dependency-motivation mechanism. Janis (1963) pointed out stress induced dependency reactions toward authority figures and suggested that increased dependency toward authority occurs because the authority can serve as a "danger control" authority which can reduce the severity of threat perceived by the individual. He indicated that the ability to establish a dependent relationship could provide another strong motivation for affiliation under stress. Helmreich and Collins (1967) tested this third

hypothesis of affiliation drives and found that apparently the prior social setting can have a strong effect on the desire to affiliate. Their study indicated that offering the company of an authority figure, who can satisfy dependency needs aroused by stress, can change the direction of affiliation in a stressful event. They concluded that dependency needs are at least one of the factors creating affiliative behavior under stress.

The implications of Schachter's hypotheses, together with the theories and findings of Festinger, Radloff, and the many others cited, suggest a framework which contributes to the explanation of the increased utilization and evident reliance of the face-to-face channel by the transacting sets of organizations during the specific periods of project problem uncertainty. It has been demonstrated that in stress or crisis periods, in which a threat is perceived and objective anxiety aroused, individuals will consistently show an increased desire for affiliation in response to one, any, or all of three mechanisms: (1) self evaluation - individuals may need others for evaluation of their own emotional reactions, and individuals in the same emotional state can provide needed information on what responses are appropriate to ambiguous arousal cues; (2) direct anxiety

reduction - the company of others may also provide a direct reduction of the anxiety which the individual feels; and (3) dependency motivation - increased dependent authority relationship may occur because the authority can serve as a "danger authority" which can reduce the severity of the threat perceived by the individual.

In situations concerning a transacting set of a prime and sub organization in which a design or technical enigma or impasse occurs, the project problem is perceived by the project manager and relevant personnel of the prime and sub organization as a definite/real threat because of unacceptable delays, additional and unplanned costs, and possible contract penalties or contract cancellation. In this period of uncertainty or stress, the project manager and key personnel of both transacting organizations perceive the threat as common, all experience a comparable or similar state of emotion and anxiety arousal, and all realize the consequences and repercussions of a non-delivery contract. Also, the project manager of the prime organization is the designated formal authority figure on whose shoulder falls the responsibility for the efficient and effective management of the overall project and who normally initiates the plans or steps to alleviate the situation. The

conditions are present, therefore, for any or all of the three affiliative mechanisms to develop. The comparable and similar anxiety situation and emotional state of the individuals facilitates self evaluation and direct anxiety reduction, and the position of the project manager facilitates the dependency-motivation mechanism. The result is normally face-to-face affiliation, as the results of this study have markedly and discernibly demonstrated.

This section has presented a possible general theoretical explanation or framework for some of the empirical findings of this study relevant to the reduction of uncertainty through the utilization of the face-to-face interpersonal communication channel. Two sub frameworks have been discussed and examined to aid in the explanation of the utilization of the face-to-face channel in the different periods and situations of a project - the periods of certainty or non-trouble and specific periods of uncertainty or stress. The first framework suggests the reduction of uncertainty during these periods by the utilization of the face-to-face channel in terms of communication efficiency, effectiveness, and expediency (richness). The second framework indicates the reduction of uncertainty during these

periods by face-to-face interaction in terms of the social psychology theories of social comparison, opinion evaluation, and affiliation in stress situations. This last framework demonstrates the progress that has been made in verifying and removing the cloth of ambiguity from the old saying "misery loves company". As Schachter states: "Whatever the needs aroused by anxiety, it would seem that their satisfaction demands the presence of others in a similar situation. Misery doesn't love just any kind of company, it loves only miserable company" (1959, p. 24).

III. IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The data developed in the course of this research indicate that interpersonal channel utilization between transacting sets of research and development organizations is a function of the uncertainties arising from project problems and suggests that it is directly related to uncertainties in general. Allen (1966) and Graham (1967) have shown that interpersonal communication channels are used by research and development personnel most frequently in the beginning phases of a research project as a means to develop plans and that the interpersonal channels are brought heavily into play at the end of a project for data evaluation purposes. The data of this

study show a similar pattern with increased utilization in the beginning of a project. The transacting sets of organizations for which the timeframe examined included the beginning phases of a project have all shown a discernible increase in channel utilization during this period of startup. The startup period is not an unexpected or unforeseen uncertainty but may be designated an expected uncertainty, a quasi-institutionalized uncertainty. The data obtained in this study have confirmed that not only is there an increase in interpersonal channel utilization during periods of project startup, but, more importantly, that during every period in which a specific project problem occurs, there is a marked and discernible increase in interpersonal channel utilizations. This confirms what project managers have long intuitively recognized and taken for granted. Whenever a specific project problem occurs there will be a concurrent period in which interpersonal channel utilization between the transacting organizations will definitely and pointedly increase. This suggests that in the planning and management of a project, definite steps should be taken to recognize the requirement for this initial communication behavior between organizations and to provide for it in terms of budgets, schedules,

and the like.

The data strongly indicate that two of the interpersonal channels have a much greater increase in utilization and are heavily relied on during periods of uncertainty or when uncertainty is present. These channels are the face-to-face channel primarily and the telephone conversation channel secondarily. The data correspond with the findings of Murtaugh and Payne (1962) when they concluded that oral communications constitute the fundamental, most powerful, immediate, and effective means of conveying information in the scientific and professional world. The data suggest and imply that face-to-face channel utilization, supplemented by the telephone conversation channel, functions to essentially reduce uncertainty during both non-trouble periods and periods of specific project problems or stress through the concepts or framework of richness of communication and social comparison/affiliation. This means that project managers, administrators, and project personnel must recognize the importance of these channels and should encourage and support the utilization of these channels with transacting organizations if uncertainty is to be reduced, problems solved, and decisions made both efficiently and effectively. The increased utili-

zation of face-to-face interaction through travel and visits is too often thought of as unnecessary and overly expensive in terms of a simple cost \longleftrightarrow benefit/value analysis. It must be recognized that not only is the face-to-face channel the most efficient in terms of technical and mathematical capabilities/capacities and in terms of attainment of true correspondence between sender and receiver but that it satisfies and fulfills vital, basic and natural social psychological needs and drives of relevant project personnel.

Further implications emerge from the recognition of the importance and reliance on the face-to-face channel during periods of uncertainty and the essential function the channel plays in reducing the uncertainty. The data obtained suggest that when a project problem or crisis period arises and is first recognized, an immediate response of increased face-to-face interaction supplemented by telephone conversations could possibly reduce the intensity, longevity, and seriousness of the stressful period. The research results also suggest that if a certain minimum amount or level of regular face-to-face interaction is inserted and utilized continuously throughout the life of the project, the number of problems and the intensity and longevity of problems

that did arise would be decreased or reduced. The latter idea corresponds to the engineering concept of insertion of a "dither" level.

One of the most successful Naval research and development projects ever completed was the Polaris Special Project, considered as a standard in R&D projects. The managers and administrators of the Polaris Project not only encouraged but insisted on a regular amount of face-to-face and telephone conversation channel utilization between the transacting organizations. The evaluation of the Polaris Project suggested that communication style was a significant factor in the on-time and successful completion of the project. Another significant feature of the Polaris was the no-ceiling budget on the utilization of the two richer channels.

More research is needed to explore these implications. Further research would be useful in which the differences resulting from adding or not adding a substantial amount of face-to-face interaction at the immediate point of recognition of a project problem, and the differences in various levels or amount of face-to-face interaction dither versus no dither level should be investigated, measured, and analyzed in fine detail.

The findings of this study indicate that the

written correspondence channel is probably one of the least important of the interpersonal channel of communications. It has been shown to be the least rich of interpersonal channels and consistently has demonstrated the least amount, if any, increase in utilization during periods of project uncertainty. This suggests that project personnel of transacting organizations utilize written communications primarily for validation or verification and for record and documentation purposes. It appears that the old cliché of "never say it - write it", has been supplemented by "talk it over, in person if possible - then if absolutely necessary, jot it down for the record".

The fairly dramatic increase and reliance on the face-to-face and telephone conversation channels during project uncertainties has implications for communication channel budgeting and channel cost analysis. Nearly all of the communication budgets for the transacting organizations were based on "hit or miss" and guessing techniques. Budget estimates cannot be realistically prepared unless communication channel patterns and behavior are understood and unless accurate cost estimates are known. A fruitful area for further research would seem to lie in an exploration of direct and indirect costs of utilization of the various interpersonal

communication channels between transacting organizations. Further research is also needed for a complete understanding of the multiple variables and factors affecting interpersonal channel utilization.

This study has indicated that certain types of uncertainties will result in a higher continuous or regular use of the face-to-face and telephone conversation channels among transacting organizations. In addition, it has been indicated that the reduction and possible preclusion of uncertainty during project problem periods is most efficiently and effectively accomplished through increased utilization and reliance on face-to-face interactions supplemented by telephone conversations. Not only will the utilization of these two channels increase at the beginning and end of a project, but will increase discernibly during the occurrence of every project problem and its associated period of uncertainty. Communication channel budgets might now be more realistically planned for and estimated with knowledge that during the project life there will be periods when these two channels will be required and used in a greater volume and frequency. The Polaris Special Project has indicated that a no-ceiling type of budget for these two channels was a successful and significant management technique.

Unexpected and unforeseen project problems and crisis type periods will inevitably arise in every project. However, in many organizations travel and telephone funds are normally arbitrarily reduced at the first sign of "tight" money or cost reduction programs. The interviews with project managers and personnel have indicated that in other organizations events which arise unexpectedly during the project often cannot be dealt with properly because funds were not budgeted and included in cost estimates that could be used to cover them. Therefore, it appears that funds should be made available and established in the transacting organizations to enable quick responses to be made to unexpected problems. If a liberal and flexible channel utilization budget cannot be established or is not feasible, then emergency or contingency funds should be established and made available.

It appears from the data of this study that there are definite gradations in the rate of increase and decrease of utilization of the face-to-face and telephone conversation channels. The gradual crescendo rise in utilization as a period of uncertainty occurs suggests that this could be a valuable management warning tool or indicator of an impending problem or period of uncertainty and stress. By close examination of the utilization

figures of the two channels, it is possible that management may be able to recognize, at an earlier time than presently possible, the germination of a project problem or crisis and be able to initiate steps that would reduce the intensity and longevity of the uncertain period. This requires data that show the fine structure of perturbation of these interpersonal channels. Further research is needed, therefore, to study, examine, and measure the gradation or perturbation structure using a short, close-in-time interval measurement. Such a study would result in a fine-grain study indicating a more discernible pattern of gradation or perturbation, and demonstrating the feasibility of this structure as a management early warning indicator.

This study has suggested that there is an apparent trade off function or exchange value between the face-to-face and telephone conversation channels during periods of uncertainty. It appears that up to some point, a decrease in face-to-face interaction can be compensated for by substituting an increase in telephone conversation utilization. It implies that during an uncertain period, the telephone could be an effective substitute for long distance travel when conditions negate the practicality of travel because of time considerations or

temporary restrictions of travel funds. The trade off phenomenon appeared in only two different sets of transacting organizations in this study. Further research is needed to determine if the suggested exchange function operates for different types of uncertainties and for different levels of intensity of uncertain periods. As a situation or period becomes more critical or stressful, is this trade off function still valid, or is there a point where face-to-face interaction is absolutely required and cannot be substituted for? Additionally, if a trade off or exchange function is feasible, how much increase in utilization of the telephone is necessary as an effective substitute for one face-to-face visit? Allen (1966) indicates that relative value of channels is greatly affected by both situational and personality considerations. Future research would also have to assess these factors in any study of an exchange value between the two channels.

The findings of this study indicate that there is an apparent inter-relationship of communication between the prime organization, sub organization, and the monitoring sponsoring organization during critical periods of uncertainty. It appears that during certain levels of periods of uncertainty not only will there be an

increase in interpersonal channel utilization between the prime and sub organizations but also, concurrently, an increase in utilization between the prime and monitoring organizations. This is extremely important to project managers and administrators of both the prime and monitoring organizations for realistic and effective planning and managing of a project and for formulating policies and budgeting for channel utilization. Further research is needed to determine if there is some degree, intensity, or characteristic of project problem uncertainty necessary before the utilization of interpersonal channels between the prime and monitoring organizations increase concurrently with the increased channel utilization between the prime and sub organizations. The two periods of uncertainty of this study in which this interrelationship has occurred have both been of an intense or critical nature. One period concerned the cancellation and termination of a contract with a sub organization, and the second period concerned the occurrence of project problems with two different sub organizations during the same timeperiod.

An intriguing finding of this research indicates that there is a basic "noise" level or amount of interpersonal communication channel utilization in each set

of transacting organizations, and that this level or amount varies in intensity between each set of transacting organizations. The "noise" level may be high for some sets and relative low for other sets of transacting organizations, but no matter what project characteristics or technical factors are involved, it appears that there is some necessary level or amount of continuous channel utilization essential to the functioning of each set of organizations. The recognition of this "noise" level has implications for both management and the understanding of the communication \longleftrightarrow organization interface. Each organization apparently has its own coding, selection, and filtering system/processes of incoming and outgoing communication. This coding and filtering system assimilates information transmitted or received by a limited set of coding categories and imposes omission, selection, distortion, refinement, and transformation upon the information.

Coding and filtering may partially account for the marked increase in utilization of the interpersonal channels during the startup phase of a project. Each transacting organization has a different coding and filtering system. This initial interface between two organizations requires a period of adjustment, tuning,

and establishment of communication "lines" between the organizations. Once this has been accomplished and there is an interface between the coding and filtering systems of each organization, it appears that the level of utilization and interaction decreases to a minimum level necessary for the continuous functioning and maintenance of the "open" communication network. This indicates that it is necessary to maintain some level of regular or continuous channel interaction between the organizations, as a stoppage over a period of time would require a re-establishment of the interface between the organizations. Katz and Kahn (1965) have suggested a theoretical background for this interface:

Individuals, groups, and organizations share a general characteristic which must be recognized as a major determinant of communication: the coding process. Any system which is the recipient of information, whether it be an individual or an organization, has a characteristic coding process, a limited set of coding categories to which it assimilates the information received. Organizations, too, have their own coding systems which determine the amount and type of information they receive from the external world and the transformation of it according to their own systemic properties. The different functions and dynamics of organizations imply that each organization will respond to intelligence input in different ways and that each will seek out particular information to meet its needs. The boundary condition is responsible for the dilemma that persons within an organization cannot perceive things and communicate about them in the same way an outsider would. If a person is within an organization, he sees its operations differently than if

he were on the outside looking in (pp. 227-228). A fruitful area for further research would be a study to examine and measure the "noise" level and the factors or variables which affect the interface between two organizations, and to determine if there is, in reality, a minimum amount or level that is necessary for the efficient functioning of transacting sets of organizations.

The focus of this study has been upon the utilization of interpersonal communication channels during varying project conditions. The findings have concentrated on the utilization of channels during periods of uncertainty and during periods of non-trouble or certainty. Two types of uncertainties or variables were examined which indicate that they affect or influence the degree of total interpersonal channel utilization between differing sets of transacting organizations of a common project. It is apparent that these are only two of a possible number of factors or variables which account for the variance in and which continuously act on the degree of channel utilization between differing sets of transacting organizations. Further research is needed to identify, measure and examine these other factors or variables and to determine their importance and influence

on the utilization behavior and patterns between different sets of transacting organizations. The analysis and examination of these variables such as location of organization, explicit and implicit travel and telephone policy, prior and present inter-organizational relationships may aid in the understanding and management of the interpersonal channel utilization processes between organizations. These variables or factors may also contribute to the planning and finalizing of management policies and decisions such as the selection of sub organizations by the prime organization. The length and extent of previous associations, location of organizations, and determinability of products or services, all related to the expense incurred in varying amounts and types of communication channel usage, can be an important factor in the sub organization selection processes.

The findings of this study have high lighted several aspects of inter-organizational communication channel utilization which the project managers and personnel of research and development organizations have probably taken for granted or intuitively recognized all along. However, as E. T. Hall points out, examining and discussing these processes changes an individual's relation with them. It enables individuals to move into an

active and understanding correspondence with these important and relevant processes which are all too frequently taken for granted. The findings and data of this study have also indicated aspects of inter-organizational communication channel utilization which may contribute to the further understanding and enlargement of knowledge of the research and development communication ↔ organization interface. The implications of the findings of this study and the recommendations for further research suggest that the communication ↔ organization interface between transacting organizations of research and development projects and the process of information transfer and diffusion within the scientific and technical communication system should serve as a fruitful and important focus for future research.

APPENDIX A
DATA RECORDING FORM

DATA RECORDING FORM

Month Week	Prime Organiza- tion	Sub Organiza- tion	Sub Organiza- tion	Sub Organiza- tion	Sub Organiza- tion	Sub Organiza- tion

BIBLIOGRAPHY

- Abelson, P. H. "Custodians of Knowledge". Science. Vol. 159, 9 February, 1968.
- Allen, Thomas J. The Use of Information Channels in R&D Proposal Preparation. Working Paper #97-64. Alfred P. Sloan School of Management, MIT, October, 1964.
- Allen, Thomas J. Managing the Flow of Scientific and Technological Information. Cambridge, Mass: MIT, September, 1966.
- Auerbach Corporation. DOD User Needs Study, Phase I. Philadelphia, Penn: Final Technical Report 1151-TR-3, May, 1965.
- Basowitz, H., Persky, H., Korchin, S., and Grinker, R. Anxiety and Stress. New York: McGraw-Hill, 1955.
- Bernal, J. D. "The Transmission of Scientific Information: A User's Analysis". Proceeding of the International Conference on Scientific Information. Washington, D.C.: NAS/NRC, 1959.
- Berul, L. Methodology and Results of the DOD User Needs Survey. Philadelphia, Penn: Auerbach Corporation. Report PR 7500-130, 1965.
- Binder, A. "Statistical Theory". Annual Review of Psychology. Edited by P.R. Farnsworth, O. McNemar. 1964.
- Birdwhistell, R. L. "Some Body Motion Elements Accompanying Spoken American English". Communication: Concepts and Perspectives. Edited by F. Dance. Washington: Spartan Books, 1967.
- Blau, P. M., and Scott, W. R. Formal Organizations: A Comparative Approach. San Francisco: Chandler Publishing, 1962.
- Bodensteiner, W. D. Preliminary Specifications and Design of an Information and Communication System For Scientists. Unpublished report, Graduate School of Business, University of Texas, 1969.
- Bondi, H. "Why Scientists Talk". The Advancement of Science. September, 1962.

- Borman, E. G., Howell, W. S., Nichols, R. G., Shapiro, G. L. Interpersonal Communication in the Modern Organization. Englewood Cliffs, New Jersey: Prentice-Hall, 1969.
- Brissey, F. L. and Hills, R. J. Problems, Problem-Solving, and Human Communication. Washington, D.C.: Technical Report, AF05R 1055-66, February, 1969.
- Chein, I. "An Introduction to Sampling". Research Methods in Social Relations. Edited by C. Selltitz, M. Jahoda, M. Deutsch, S. W. Cook. New York: Holt, Rinehart and Winston, 1964.
- Cherry, C. On Human Communication. New York: John Wiley, 1957.
- Clark, C. T. and Schkade, L. L. Statistical Methods for Business Decisions. Cincinnati: Southwestern Publishing, 1969.
- Committee on Scientific and Technical Information. National Systems for Scientific and Technical Information. Washington, D.C., 1965.
- Cuadra, C. "Introduction to the ADI Annual Review". Annual Review of Information Science and Technology. Edited by C. Cuadra. New York: John Wiley. Vol. 1, 1966.
- Darley, J. and Aronson, E. "Self-evaluation Vs. Direct Anxiety Reduction as Determinants of the Fear-Affiliation Relationship". Journal of Experimental Social Psychology. 1966, Supplement 1, 66-79.
- Federal Council for Science and Technology. Proceedings: Second Symposium on Technical Information. U.S. Government Printing Office, 1964.
- Festinger, L. "Theory of Social Comparison Processes". Human Relations. 1954, 7, 117-140.
- Festinger, L. and Katz, D. Research Methods in the Behavioral Sciences. New York: Dryden, 1953.
- Fiedler, F. "Personality and Situational Determinants of Leadership Effectiveness". Group Dynamics. Edited by D. Cartwright and A. Zander. New York: Harper and Row, 1968.

- Fishenden, R. M. "Methods By Which Research Workers Find Information". Proceedings of the International Conference on Scientific Information. Washington, D.C.: NAS/NRC, 1959.
- Fordor, J. A., Jenkins, J. J., and Saporta, S. "Psycholinguistics and Communication Theory". Human Communication Theory. Edited by F. Dance. New York: Holt, Rinehart, and Winston, 1967.
- Freedle, R. O., Graham, W. R. and Zavala, A. "Informal Scientific and Technological Communications". Exploration of Oral/Informal Technical Communication Behavior. Edited by W. Graham. Washington, D.C.: American Institutes for Research, August, 1967.
- French, J. R. P. "Experiments in Field Settings". Research Methods in the Behavioral Sciences. Edited by L. Festinger and D. Katz. New York: Dryden, 1953.
- Freud, S. New Introductory Lectures and Psychoanalysis. New York: Norton, 1923.
- Garvey, William D., and Griffeth, Belver C. "Scientific Communication as a Social System". Science. 1 September, 1967 1011-1016.
- Gerard, H. "Emotional Uncertainty and Social Comparison". Journal of Abnormal and Social Psychology. 1963, 568-573.
- Gerard, H., and Rabbie, J. "Fear and Social Comparison". Journal of Abnormal and Social Psychology. 1961, 62, 586-592.
- Glass, B., and Norwood, S. H. "How Scientists Actually Learn of Work Important to Them". Proceedings of the International Conference on Scientific Information. Washington, D.C.: NAC/NRC, 1959.
- Gloege, W. P. and Graham, W. R. "Informal Communication of Science Information: A Review". Exploration of Oral/Informal Technical Communication Behavior. Edited by W. Graham. Washington, D.C.: American Institutes for Research, August, 1967.
- Goffman, E. The Presentation of Self in Everyday Life. New York: Anchor, 1959.

- Graham, W. R. and Wagner, C. B. Exploration of Oral/Informal Technical Communications Behavior. Washington, D.C.: Final Report, American Institutes for Research, August, 1967.
- Graham, W. R. "A Questionnaire Study of Informal Scientific and Technological Communications". Exploration of Oral/Informal Technical Communication Behavior. Edited by W. Graham. Washington, D.C.: American Institutes for Research, August, 1967.
- Graham, W. R. and Zavala, A. "The Social Psychology of Informal Communications Among Scientists". Exploration of Oral/Informal Technical Communication Behavior. Edited by W. Graham. Washington, D.C.: American Institutes for Research, August, 1967.
- Guilford, J. P. Psychometric Methods. New York: McGraw-Hill, 1954.
- Halbert, M. H., and Ackoff, R. L. "An Operations Research Study of the Dissemination of Scientific Information". Proceedings of the International Conference on Scientific Information. Washington, D.C.: NAS/NRC, 1959.
- Hall, E. T. The Silent Language. Greenwich, Conn.: Fawcett World Library, 1959.
- Hayakawa, S. I. Language in Thought and Action. New York: Harcourt, Brace, and World, Inc., 1964.
- Helmreich, R. L., and Collins, B. E. "Situational Determinants of Affiliative Preference Under Stress". Journal of Personality and Social Psychology. 1967, 6, 79-85.
- Herner, S. "The Information-Gathering Habits of American Medical Scientists". Proceedings of the International Conference on Scientific Information. Washington, D.C.: NAS/NRC, 1959.
- Holtzman, W. H., and Bitterman, M. E. "A Factorial Study of Adjustment to Stress". Journal of Abnormal and Social Psychology. 1956, 52, 179-185.
- Hymes, D. "The Anthropology of Communication". Human Communication Theory. Edited by F. Dance. New York: Holt, Rinehart, and Winston, 1967.

- Janis, I. "Group Identification Under Conditions of External Danger". British Journal of Medical Psychology. 1963, 36, 227-238.
- Janis, I., and Leventhal, H. "Human Reactions to Stress". Handbook of Personality Theory and Research. Edited by E. Borgatta and W. Lambert. New York: Rand McNally, 1968.
- Katz, D., and Kahn, R. L. The Social Psychology of Organizations. New York: John Wiley, 1965.
- Kolasa, B. J. Behavioral Science for Business. New York: John Wiley, 1968.
- Latane, B., Eckman, J., and Joy, V. "Shared Stress and Interpersonal Attraction". Journal of Experimental Social Psychology. 1966, Supplement 1, 80-94.
- Lazarus, R. Psychological Stress and the Coping Process. New York: McGraw-Hill, 1966.
- MacKay, D. M. "Communication and Meaning: A Functional Approach". Cross-Cultural Understanding. Edited by F. S. C. Northrup. New York: Harper and Row, 1964.
- Markel, N. N. "The Basic Principles of Descriptive Linguistic Analysis". Current Perspective in Social Psychology. Edited by E. P. Hollander and R. G. Hunt. New York: Oxford University Press, 1963.
- McLeod, J. M. "The Contribution of Psychology to Human Communication Theory". Human Communication Theory. New York: Holt, Rinehart, and Winston, 1967.
- Menzel, H., and Glock, C. Y. The Flow of Information Among Scientists. New York: Columbia University, 1958.
- Menzel, Herbert. Planned and Unplanned Scientific Communication. Publication A-259, Bureau of Applied Social Research, Columbia University, 1959.
- Menzel, H. "The Information Needs of Current Scientific Research". The Library Quarterly. Vol. 34, January, 1964.
- Menzel, Herbert. "Scientific Communication: Five Sociological Themes". American Psychologist. Vol. 21, 1966.

- Menzel, H. "Information Needs and Uses in Science and Technology". Annual Review of Information Science and Technology. Edited by C. Cuadra. New York: John Wiley. Vol. 1, 1966.
- Menzel, H. "Can Science Information Needs Be Ascertained Empirically"? Communication: Concepts and Perspectives. Edited by L. Thayer. Washington, D.C.: Spartan Books Co., 1967.
- Miller, N. and Zimbardo, P. "Motives for Fear-Induced Affiliation: Emotional Comparison of Interpersonal Similarity". Journal of Personality. 1966, 34, 481-503.
- Morris, C. W. Signification and Significance: A Study of the Relations of Signs and Values. Cambridge, Mass: The MIT Press, 1964.
- Murtaugh, J. S. and Payne, G. L. "Communication in the Biomedical Sciences". The Journal of Medical Education. 37, 1962.
- National Science Foundation. Federal Funds for Research, Development, and Other Scientific Activities. Vol. 15, 1966.
- Newcomb, T. M. "An Approach to the Study of Communication Acts". Psychological Review. Vol. 60, 1953.
- Newcomb, T. M., Turner, R. H., and Converse, P. E. Social Psychology. New York: Holt, Rinehart, and Winston, 1965.
- Orr, R. H., Coyl, E. B., and Leeds, A. A. "Trends in Oral Communication Among Biomedical Scientists". Federation Proceedings. 1964, 23, 1146-1154.
- Paisley, W. J. The Flow of Behavioral Science Information: A Review of the Research Literature. Palo Alto: Institute for Communication Research, Stanford University, 1965.
- Parker, E. B., Lingwood, D. A., and Paisley, W. J. Communication and Research Productivity in an Interdisciplinary Behavioral Science Research Area. Palo Alto: Institute for Communication Research, Stanford University, 1968.
- Pelz, D. C., and Andrews, F. M. Scientists in Organizations. New York: John Wiley, 1966.

- Price, D. J. Little Science, Big Science. New York: Columbia University Press, 1963.
- Radloff, R. "Opinion Evaluation and Affiliation". Journal of Abnormal and Social Psychology. 1961, 62, 578-585.
- Radloff, R. and Helmreich, R. Groups Under Stress. New York: Appelton-Century-Crofts, 1968.
- Rapoport, A. "What is Semantics". The Use and Misuse of Language. Edited by S. Hayakawa. New York: Harper and Brothers, 1962.
- Richardson, S. A., Dohrenwend, B. S., and Klien, D. Interviewing: Its Forms and Functions. New York: Basic Books, 1965.
- Rokeach, M. The Open and Closed Mind. New York: Basic Books, 1960.
- Rosenbloom, R. S., and Wolek, F. W. Technology, Information and Organization. Graduate School of Business, Harvard University, 1967.
- Ruesch, J. "Synopsis of the Theory of Human Communication". Psychiatry. 16, 1953.
- Ruesch, J. Nonverbal Communication. Los Angeles: University of California Press, 1956.
- Sandek, L. "Mans World of Facts". Data Processor. Vol. X, No. 4, November, 1967.
- Sarnoff, I., and Zimbardo, P. "Anxiety, Fear and Social Affiliation". Journal of Abnormal and Social Psychology. 1961, 62, 356-363.
- Schachter, S. The Psychology of Affiliation. Stanford: Stanford University Press, 1959.
- Schramm, W. The Process of Effects and Mass Communications. Urbana, Illinois: University of Illinois Press, 1954.
- Selltiz, C., Jahoda, M., Deutsch, M., and Cook, S. W. Research Methods In Social Relations. New York: Holt, Rinehart and Winston, 1964.

- Shannon, C. E., and Weaver, W. The Mathematical Theory of Communication. Urbana, Illinois: Illinois Press, 1949.
- Shapero, A. "Managing Technical and Intellectual Resources". Business Horizons. Vol XII, No 2, April 1969.
- Shilling, C.W., Bernard, J., and Tyson, J. W. Informal Communication Among Bioscientists. Washington, D.C: George Washington University, Biological Sciences Communication Project, 1964.
- Shils, E. A. "Social Inquiry and the Autonomy of the Individual". The Human Meaning of the Social Sciences. Edited by D. Lerner. Cleveland: Meridian, 1959.
- Siegel, S. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill, 1956.
- Smith, A. G. Communication and Culture. New York: Holt, Rinehart and Winston, 1966.
- Swanson, R. W. Information Systems Networks. Arlington, Virginia: AFOSR 66-0837, Office of Aerospace Research, USAF, June, 1966.
- Taylor, R. S. "The Process of Asking Questions". American Documentation. October, 1962.
- Thayer, L. "Communication and Organization Theory". Human Communication Theory. Edited by F. Dance. New York: Holt, Rinehart and Winston, 1967.
- Webb, E. J., Campbell, D. T., Schwartz, R. D., and Sechrest, L. Unobtrusive Measures. Chicago: Rand McNally, 1969.
- Weiner, N. The Human Use of Human Beings. Boston: Houghton Mifflin, 1950.
- Weiner, N. Cybernetics. New York: John Wiley, 1948.
- Wrightsmann, L. "Effects of Waiting With Others on Changes in Level of Felt Anxiety". Journal of Abnormal and Social Psychology. Vol 61, 1960.

Zavala, A., and Graham, W. R. "Research Manager's Suggestions on Problems of Informal Scientific Communications". Exploration of Oral/Informal Technical Communication Behavior. Edited by W. Graham. Washington, D. C.: American Institutes for Research, August, 1967.

Zimbardo, P. and Formica, R. "Emotional Comparison and Self-Esteem As Determinants of Affiliation". Journal of Personality. 1963, 31, 141-162.

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